IN WINDSOR FOREST.

From a negative by Captain Abney, R.E. Printed by the Woodburytype Process.

INSTRUCTION

IN

PHOTOGRAPHY.

BY

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THIRD EDITION.

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PREFACE TO THIRD EDITION.

At THE commencement of this year, when my publishers informed me that "Instruction in Photography" was "out of print," I had not intended to bring out another edition of it under the old designation, as Messrs. Longmans had requested me to write one of their "Text-Books of Science" on the same subject.

Circumstances, however, lately arose which showed me the advisability of reconsidering my determination, and I have therefore revised and enlarged my original work, leaving it on the same plan as before, and still find myself able to continue preparing "Photography" for Messrs. Longmans. This latter will enter much more fully into theory than it seemed advisable to do in the present Manual, which is intended rather for practical workers than for an educational series.

It has been a matter of self-congratulation that the last large edition has become so quickly exhausted, and I am induced to hope that the present one will be equally successful.

W. DE W. ABNEY,

CAPTAIN R.E.

Chatham, October, 1876.

PREFACE TO SECOND EDITION.

A SMALL edition of this Manual was originally prepared for private circulation amongst the officers and men of the corps of Royal Engineers. Much of it, however, got distributed beyond this circle, with the effect of creating such a large demand upon me for copies, that had I supplied them the numbers printed would long ago have been exhausted. Under these circumstances I determined, with the sanction of the Inspector-General of Fortifications, to bring out an edition for the general public.

As the contents have been chiefly compiled from notes, names of persons who may be connected with processes are often omitted, not from intention, but from ignorance. As it is a work of a practical character, and not a history of the art, I trust that such omissions will not affect its value.

W. DE W. ABNEY,

CAPTAIN R.E.

CONTENTS.

INSTRUCTION IN PHOTOGRAPHY.

Observation has shown that certain metallic and organic compounds undergo change in the presence of ordinary light. The change may be visible to the eye (as in the case of the darkening of silver chloride), or may be ascertained by their behaviour when certain chemical agents are brought in contact with them, as in the case of iodide of silver in the wet collodion process. It is none the less true that the latter change is as real as the former, though it be primarily unrecognizable. It is found that rays of certain colours (as well as pure white light), affect these compounds, and that those of certain other colours refuse to do so. Those coloured rays of light which will effect a change (visible or invisible) are termed actinic, or chemical, rays; all others, non-actinic. When light is decomposed by a prism, it is separated into all the colours of the rainbow, and although they pass imperceptibly from one to the other, yet, for the sake of perspicuity, they have been divided into seven, which are called primary colours. These are red, orange, yellow, green, blue, indigo, and violet. Experiment has shown that light of those colours which are included between the green and the violet are actinic, and that of these, that which produces the most rapid change in a silver salt is situated about half-way between the two. With different salts of silver the range of actinic power varies slightly, inclining more or less to the red end of the spectrum.

There are certain silver and iron compounds which have proved to be capable of being acted upon by the red rays to from a developable image, and even by dark rays below them in the spectrum; but as yet the discovery has not been utilized, hence only the ordinary silver compounds used by the photo-

grapher for camera work will be considered. It should be remembered, then, that white light only causes a chemical change in a silver salt, because, of its components, some are actinic; and it is because the red and yellow rays are non-actinic that coloured glass of these hues is used in our developing rooms, the light admitted through such glass, if it be of good quality, being incapable of producing any *primary* change on the ordinarily employed silver salt. It must also be noted that when a ray of light is decomposed by a prism into its primary colours, and these be allowed to fall upon a film containing a sensitive salt, a change in it is produced beyond the place where the extreme violet ray is seen. These rays (together with others below the red) are called dark rays of the spectrum, and are usually denoted as ultra-violet. As these produce a change in the salt, they are likewise actinic rays.

The sensitive salts of silver which are usually employed in photography are, the iodide, the bromide, and the chloride of silver. There are others, which are rarely used, and to which we may refer further on. In order to illustrate the theory of the formation of a photographic image, the iodide will be taken as a type, the action of light on the other salts being similar.

Silver iodide (Ag I) can be formed in two or more ways—by the action of a soluble iodide on a soluble salt of silver, or of iodine vapour upon metallic silver. This first method is that employed for its formation in ordinary photography: — The soluble iodide of a metal, or metalloid, such as cadmium, ammonium, &c., is brought in contact with a solution of silver nitrate; the iodine, having a strong affinity for the silver, forms silver iodide, setting the nitric anhydride free, which in its turn combines with the metal originally in combination with the iodide. Chemically, it is expressed thus—

$$\overbrace{CdI_2}^{\text{Cadmium Iodide.}} + \overbrace{2AgNO_3}^{\text{Silver Nitrate.}} = \overbrace{2AgI}^{\text{Silver Iodide.}} + \overbrace{Cd(NO_3)_2}^{\text{Cadmium Nitrate.}}$$

In the above equation, if we were to substitute Br for I, the same would hold good, the decomposition being similar.

The chemical change that takes place in the iodide of silver by the light we have very good reason to believe to be the formation of a silver subiodide. Thus—

$$\overbrace{2AgI}^{\text{Silver Iodide.}} = \overbrace{Ag_2I}^{\text{Silver Subiodide.}} + \overbrace{I}^{\text{Iodine.}}$$

If no body which will absorb iodine* be present this change will not take place, for if we thoroughly wash silver iodide, and treat it, after exposure to light, with such a developer as will be presently indicated, no alteration in it will be manifest. It will therefore be evident that in wet plate photography the silver nitrate plays an important part.

Multiplying the above equation by 6 we have 6I coming in contact with $6AgNO_3$—

Iodine.	Silver Nitrate.	Water.	Silver Iodide.	Silver Iodate.	Nitric Acid.
$\dagger 6I$	$+ 6AgNO_3$	$+ 3H_2O =$	$5AgI$	$+ AgIO_3$	$+ 6HNO_3$

It must not be supposed that this chemical change necessarily takes place in the whole of the silver iodide present. Far from it—the change may take place in an infinitely small proportion of it, perhaps only on the surface of the minute granules exposed to light.

In dry plate photography the action of light is precisely the same; but the free nitrate of silver solution is replaced in this case by some body *which will combine with iodine.*

WET-PLATE PHOTOGRAPHY.

Having treated of the action produced by light on various silver compounds, it is now proposed to describe in detail the process commonly known as the collodion wet process. The sensitive salts of silver usually employed in this process are the iodide and bromo-iodide, the former being used only for special classes of work, to which attention will be drawn. The following is an outline of the process:—1st. Soluble bromides and iodides are dissolved in collodion. 2nd. A clean glass plate is coated with a thin film of this prepared collodion. 3rd. When set, the plate is immersed in a solution of silver nitrate

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* This is not the case with silver bromide and chloride. A change is effected in these bodies without the presence of an absorbent.

† When bromine and chlorine are liberated from silver bromide and chloride respectively in the presence of silver nitrate, the reaction that takes place is somewhat different, hypobromous and hypochlorous acid being formed. The above equation is possible when the iodide is the sensitive salt, but it is doubtful if it is not simplified by oxygen being liberated, no iodate being then formed.

(usually called the bath solution), which causes the formation of silver iodide or bromo-iodide. 4th. The plate is then exposed in the camera. 5th. A developing solution is applied to bring out the image. 6th. The image is intensified or strengthened. 7th. It is fixed, and (8th) a coating of varnish is given to the dried film to protect the delicate collodion surface. In this stage the negative is complete for printing purposes.

THE GLASS PLATE.

A few remarks are necessary on the glass that should be selected for camera work. As a rule, patent plate is recommended by most authorities on the subject, as being perfectly flat and of a good polish. It must, however, be borne in mind that patent plate is really nothing more than sheet glass which has been ground to a flat surface and then polished. The outer skin of all glass is always the hardest and most compact, and consequently the patent plate is denuded of much of the original surface, and the inner portions of the sheet glass are consequently exposed to the action of the chemicals employed. In practice it is found that this glass absorbs impurities, during the photographic operations, which cannot be eliminated; and it is almost useless to expect to use the same plate above three or four times, a serious consideration to the tyro in the art when the high price of the article is remembered.

Sheet glass is generally "true" in one direction, but slightly curved in the other, but its surface is hard and well adapted for small-sized plates, where the curvature may be neglected. A good specimen of this glass is one to be recommended.

Crown glass, from the nature of its manufacture, has generally double curvature, and is therefore to be employed for large plates with great caution, as it is liable to snap in the printing-frame, and to throw portions of the picture out of focus.

Flatted crown is not open to this objection, but if it be really flatted its cost should be nearly that of patent plate. It has a hard surface, and when a true sample of it is to be obtained there is nothing better that can be used.

For large plates, say over 15in. by 12in., patent plate is recommended; for the inferior sizes, flatted crown; or, failing this, the best sheet glass.

Flatted crown has only one surface that is smooth, the process

of flattening (which consists in heating the ordinary crown to a red heat and allowing it to flatten on a plain surface) making the other slightly irregular.

CLEANING THE GLASS PLATE.

In order to make a plate chemically clean, some body must be found which will free it from mechanical dirt—such as dust—and also from grease. Alcohol has the property of holding most kinds of the latter in solution, hence it generally forms a portion of a plate-cleaning formula. Any alkali will turn grease into soap, rendering it soluble in water; hence this is often recommended as an addition. To free a plate from mechanical dirt, insoluble powder of an impalpable description is found to answer well when made up in a paste, hence the employment of tripoli powder and rouge. Common whitening has the property of absorbing grease when dry; hence a cream of this made up with water is sometimes applied to a plate, allowed to dry, and rubbed off in that state. The usual formulæ for a plate-cleaning solution is tripoli powder; spirits of wine sufficient to form a thin cream; liquor ammonia, about ten drops to each ounce of the cream. Rouge may be substituted for the tripoli powder, but unless it be of the finest nature, it is liable to cause scratches. It has also the disadvantage of injuring the bath if any be carried into it by the plate.

Plates carrying old varnished negatives, which are to be used for fresh pictures, should be allowed to soak in soda and water (one ounce of washing soda to two pints of water). This will generally secure the film leaving the plate. Should the films be unvarnished, hot water may be employed to remove the collodion. In both cases the plates must be treated with the cleaning solution.

It may happen that plates are slightly scratched, and refuse to become clean by ordinary means. Resort may then be had to albumen, &c., as given for dry plates.

COLLODION.

Collodion is gun-cotton (*i.e.*, pyroxyline) dissolved in a mixture, varying in proportions, of alcohol and sulphuric ether. Its qualities vary with the kind of gun-cotton and with the proportions of the solvents used.

Pyroxyline is cotton or fibre (cellulose or lignine) which has been altered in chemical composition by treatment with a mixture of nitric and sulphuric acids, or an equivalent of the former. The change that takes place is due to the combination of peroxide of nitrogen with the cellulose or lignine. The chemical action may be symbolized as follows:—

$$\overbrace{C_6H_{10}O_5}^{\text{Cotton.}} + \overbrace{2H{\cdot}NO_3}^{\text{Nitric Acid.}} + \overbrace{H_2SO_4}^{\text{Sulphuric Acid.}} = \overbrace{C_6H_8(NO_2)2_2O_5}^{\text{Pyroxyline.}}$$
$$+ \overbrace{H_2SO_4}^{\text{Sulphuric Acid.}} + \overbrace{2H_2O}^{\text{Water.}}$$

It will be noticed that the sulphuric acid remains unchanged. Its employment is owing to its affinity for water. Hydrogen from the cotton is abstracted, and combines with the oxygen liberated from the nitric acid. This forms the water which the sulphuric acid absorbs. The formula shows that two equivalents of hydrogen are displaced by two equivalents of nitric peroxide. When three equivalents are displaced we have the true explosive gun-cotton. The difference in the temperature of the acids, &c., determines whether tri-nitro or di-nitro (pyroxyline) cellulose will be formed.

The manufacture of pyroxyline is one of considerable difficulty, though not at all out of the range of ordinary skill. For amateurs the second process will, it is believed, be the most useful. The general directions given are those found in Hardwich's Photographic Chemistry.

1st Process.—Sulphuric acid 1·845 at 60° F.			18 fluid ounces.*	
Nitric acid 1·457	...	...	6	,,
Water ...	...	...	$4\frac{3}{4}$	,,

The water is first poured into a strong glazed porcelain basin, the nitric acid *next* added, and, *lastly*, the sulphuric acid. The mixture is well stirred with a glass rod. The temperature will now be found to be somewhere about 190°. It must be allowed to cool to 150°, and this temperature must be maintained on a water-bath. A dozen balls of cotton wool, weighing about thirty

* It need scarcely be said that great care must be taken to prevent the acid coming in contact with the skin or dress. An india-rubber apron and pair of gloves are useful to save the one and the other from hurt.

grains (which have previously been well washed and dried), should now be immersed separately in the fluid with the aid of a glass spatula. Each ball should be pressed separately against the side of the basin till it is evident that the acids have soaked into the fibre. Care must be taken that each one is immersed at once. Failing this, a different chemical combination takes place, and nitrous fumes are given off, and the success of the operation will be vitiated. Immersing the dozen balls will take about two minutes. The basin should after this be covered up for about ten minutes.* At the expiration of this time the whole of the cotton should be taken up between two glass spatulas, and against the sides of the clean porcelain capsule as much of the acids as possible should be squeezed out. The cotton should then be dashed into a large quantity of water, and washed in running or frequent changes of water for twenty-four hours. Finally, when it shows no acid reaction to blue litmus paper, it is dried in the sun or on a water-bath.

2nd Process.—Sulphuric acid of commerce		6 fluid ounces
	Dried potassium nitrate ...	$3\frac{1}{2}$ ounces (Av.)
	Water	1 fluid ounce
	Best cotton wool	60 grains

Mix the acid and water in a porcelain vessel, then add the nitrate (which has previously been dried on a metal plate to about 250°, and then pulverized) by degrees, stirring with a glass rod until all lumps disappear and a transparent viscous fluid is obtained. This will occupy several minutes.

The whole of the cotton wool must now be separated into balls the size of a walnut, and immersed as stated in the first process, care being taken that the temperature is kept up to 150°. The cotton is then left ten minutes, and washed as before. Mr. Hardwich states that the chances of failure in this process "are very slight, if the sulphuric acid be sufficiently strong, and the sample of nitrate not too much contaminated with chloride of potassium." If failure occur through the cotton dissolving in either of the mixtures, a drachm less water must be used.

In both processes the operation may be conjectured to be successful if the cotton tear easily in the hand, and if the original lumps cannot be easily separated. Should nothing but fragments

* This prevents the access of the air to the fluid, and consequent absorption of oxygen. A neglect of this precaution will increase the chance of nitrous fumes being evolved.

of the lumps be detected, it is probable (if the acids used have been of the strength given above) that the temperature has been allowed to fall. When dry, the pyroxyline, on pulling by the hand, should break up into little bits, and not resemble the original cotton in texture.

The weight of good pyroxyline should be greater than the original cotton by about 25 per cent.

If the acids employed be too strong, the pyroxyline will be much heavier than this percentage, and on solution yield a thick glutinous collodion; whereas, if the acids have been too diluted, it will probably weigh less than the original cotton, and yield a collodion adhering firmly to the plate, but giving negatives of an abnormal softness; with this specimen any small particles of dust that may fall on the glass will form transparent marks. The formula given above steers between the two extremes.

The following are formulæ which experience has shown are good for plain collodion:—

No. 1.	Pyroxyline	...	...	... 55 to 65 grains
	Alcohol ·820	...	...	... $4\frac{1}{2}$ ounces
	Ether ·725	...	...	... $5\frac{1}{2}$ „
No. 2.	Pyroxyline	...	...	... 55 to 65 grains
	Alcohol ·820	...	...	... 5 ounces
	Ether ·725	...	...	... 5 „

No. 1 is most suitable for winter; No. 2 for summer work. The more alcohol in proportion to the ether that is used the slower will the collodion set. A limit, however, to the proportions that can be used arises from the fact that if the alcohol be added in excess, the film which contains the sensitive salts of silver becomes streaky and slow in securing the impressions of the photographic image; whilst if the excess be of ether, the film becomes too contractile, and has a tendency to split on drying. In mixing the collodion the alcohol should be added first to the pyroxyline, as by so doing its dissolution is aided. It must also be remembered that the quantity of pyroxyline given above is dependent on its quality, whether it tend to form a gelatinous or limpid collodion. In the former case, less must be used; whilst in the latter, more may be added.

When plain collodion has been prepared, and a copious

addition of water made to it, it is found that a portion of the pyroxyline remains in solution in the water, the precipitated portion being of a finer quality than the original. If this be dried and made up into collodion once more, it yields a beautifully textureless film. Should this method of "refining" the pyroxyline be determined upon, coarser and cheaper quantities of solvents may be employed in the first instance.

Dr. Liesegang introduced a form of pyroxyline called papyroxyline. It is prepared from paper instead of cotton, and its value for giving tough films is great. Four grains of papyroxyline are equivalent to five of pyroxyline. A judicious mixture of the two in the solvents gives highly satisfactory results.

Iodides and bromides of metals are added to the plain collodion to render it capable of forming a fine layer of iodide and bromide of silver in the negative bath. If iodides are used alone a dense image is formed with but little detail in the high lights, and a long exposure is necessary in the camera. Bromides used alone give a faint image, but full of detail, and the time required to impress a latent image on the sensitized film is shorter than when iodides alone are employed. It is thus evident that a judicious mixture of the two will give a film which, when sensitized, has the delicacy of the bromide and the density of the iodide, whilst the time of exposure will be somewhat between that required for the two separately.

The iodides and bromides of zinc, potassium, ammonium, and cadmium, have all been tried by various makers. The two last are the staple iodizers and bromizers employed.

The following is a list of the combining proportions of iodine and bromine in the iodides and bromides of certain of the metals. For others they can be calculated from the table in the Appendix:—

In 10 grains of	potassium	iodide	7·64	grains	iodine
,, ,,	,,	bromide	6·64	,,	bromine
,, ,,	cadmium	iodide	6·92	,,	iodine
,, ,,	,,	bromide	5·88	,,	bromine
,, ,,	ammonium	iodide	9·40	,,	iodine
,, ,,	,,	bromide	8·16	,,	bromine
,, ,,	magnesium	iodide	9·14	,,	iodine
,, ,,	,,	bromide	8·59	,,	bromine
,, ,,	zinc	iodide	7·95	,,	iodine
,, ,,	,,	bromide	7·10	,,	bromine

A standard iodizing solution having been arrived at by experiment with any of the iodizers and bromizers given above, the value of the others may be determined.

The following is a standard that has been found to answer well:—

No. 1.—*Cadmium iodide	... ...	$4\frac{1}{2}$ grains
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce

On referring to the table the following modifications arise in the formula where alkaline salts are used. We shall have then for one formula:—

No. 2.—Ammonium iodide	... ...	$3\frac{1}{2}$ grains
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce
No. 3.—Cadmium iodide ...	... ...	$2\frac{1}{4}$ grains
Ammonium iodide	... ...	$1\frac{2}{3}$,,
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce
No. 4.—Ammonium iodide	... ...	3 grains
Cadmium iodide ...	... ...	$\frac{1}{2}$ grain
Ammonium bromide	... ...	$1\frac{2}{3}$ grains
Plain collodion ...	... ...	1 ounce
No. 5.—Ammonium iodide	... ...	4 grains
Cadmium bromide	... ...	$1\frac{1}{4}$,,
Plain collodion ...	... ...	1 ounce

No. 1 should be mixed at least six months before use; it then gives a delicate image and fine detail.

No. 2 should be mixed two months before use, and answers well for landscapes.

No. 3 should be prepared four months before use, and is good for portraiture.

No. 4 may be used after mixing two or three days, and is a good "general purpose" collodion.

No. 5 is a collodion much to be recommended. It gives fair density with detail, both in the high lights and shadows; it can be used two or three days after making.

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* Cadmium renders collodion glutinous on first iodizing. When kept, it becomes more limpid. Ammonium fits collodion for more immediate use, as t does not cause it to become glutinous, even on first iodizing.

The following general rules may be given for modifying the tendencies of collodion :—

1. If a *decrease* of contrast and more detail be required, add bromide.

2. If violent contrasts are wanted, the iodides should be increased and the bromides diminished. One quarter-grain of bromide to the ounce of collodion is found to be sufficient to secure cleanness in the shadows, and all but this quantity may be left out if necessary.

As before stated, for certain classes of work it may be necessary to resort to simply iodized collodion, no bromide being admissible. The following are formulæ which have been adopted :—

No. 6.—Ammonium iodide	...	...	4 grains
Plain collodion ...	...	...	1 ounce
No. 7.—Cadmium iodide	...	...	5 grains
Plain collodion ...	...	...	1 ounce

No. 6 should be iodized almost immediately before use.

No. 7 requires keeping, and is a most stable collodion.

It should here be noted that it is customary, though not necessary, to leave out half the alcohol from the plain collodion, and dissolve the iodide or bromide in the quantity thus omitted. This procedure has advantages, and may be followed if considered convenient.

Collodion should be stored in a dry and cool place ; if otherwise, the ether is apt to become decomposed, which, in its turn, decomposes the pyroxyline. Collodion made with pure spirit and neutral cotton will be colourless after iodizing, but if made with impure solvents it will become first dark, but may afterwards return to its colourless condition. Should the pyroxyline be acid (not sufficiently washed after preparation), the collodion will become sherry-coloured almost immediately, but will not keep in good working condition for long.

Methylated alcohol and ether are often employed by manufacturers as solvents. Experience teaches that, although apparently harmless at first, they both, particularly the former, contaminate the silver nitrate bath if used for any length of time. It is also noticeable that a collodion made with pure solvents frequently refuses to work in a bath in which adulterated solvents are found.

Collodion should be always labelled and dated after manufacture and iodizing. This precaution will be found of the greatest use in selecting a specimen suitable for any particular purpose. The following is a specimen of a label :—

PLAIN COLLODION MADE 15th JULY, 1876.

Pyroxyline (prepared 1st of June, 1870) ...	6 grains
Papyroxyline	2 ,,
Sulphuric ether (pure)	½ ounce
Alcohol ·820	¼ ,,

Iodized 4th August, 1876.

Ammonium iodide	2½ grains
Cadmium iodide	2 ,,
Cadmium bromide	2 ,,
Alcohol ·820	¼ ounce

Any bottle of collodion thus labelled will tell its own tale, and be a guide for future manufacture. With the collodion of commerce all you can do in labelling is to give its date of iodizing; even this will be found very useful.

When the iodized collodion is of a pale straw colour, it is in its most sensitive condition. After it assumes the dark brown sherry colour, from the liberation of iodine,* it becomes less sensitive, and is more apt to give harsh pictures.

When plain collodion is prepared, it should be tested before iodizing. A plate should be coated, and it should be observed if it dry with any opalescence. Next, the toughness of the film should be tested to see if it be powdery, or if it come away in strips to the touch of the finger. After it is iodized it should be tried by taking two or three negatives, the behaviour of the films being carefully noted. It is useful to have a sample of good standard collodion at hand with which to compare it. If the two halves of a stereoscopic plate be coated with the two collodions respectively, and the sensitized films be exposed simultaneously, their relative sensitiveness and densities may be readily determined, and the results should be noted for future guidance. Any defect in the collodion should, of course, be corrected.

Collodion which yields a thick creamy film gives a "plucky" image, whilst a limpid collodion gives one thin and transparent.

* The whole of iodine must be liberated before any bromine can be found in a free state.

This latter can be improved by adding a grain or two of pyroxyline to each fluid ounce. Should this defect arise from the use of alcohol which is too anhydrous, it may be rectified by the addition of a drop or two of water to each fluid ounce. Collodion that has been iodized a long time often has this defect.

It will be found advantageous at times to mix the collodions prepared by different formulæ; thus, a collodion yielding great intensity of image should be mixed for general purposes with one which is deficient in this quality. This remark applies not only to home-made, but also to commercially supplied, collodions.

When testing the plain collodion, should the film dry matt, the sample must be rejected, as the pyroxyline must be unsuitable.

Should the film after sensitizing appear like watered silk, then the collodion is too alcoholic, or else contains too much iodide and bromide. The probable cure for this is the addition of a drachm to the ounce of plain collodion prepared according to formula 1, page 8. Should the defect arise solely from the collodion being too alcoholic, it is probable that if the film be allowed to set more thoroughly before sensitizing, a cure will be effected. When collodion is under-iodized, the developed image will be poor and flat, though it is necessary to distinguish between this cause for the defect, and that due to impurities that may occur in the negative bath.

If the film, on drying, show "crape markings," the plain collodion has been prepared with solvents of too great a specific gravity—*i.e.*, with too much water in their composition. To remedy this defect, an iodized collodion formed of absolute ether and alcohol should be added till the markings disappear.

Should the collodion, on setting, prove of a horny repellent nature, the defect may be cured by shaking it up with a small quantity of carbonate of soda, and decanting the supernatant liquid from the residue. A drop or two of water to the ounce will frequently answer the same purpose.

If collodion be made up with absolute alcohol and ether and the above amount of iodides and bromides, it will be found that the plate has the appearance of being stained with opaque streaks, especially at the corner of the plate from which the collodion was poured off, where, consequently, it was least set. To remedy this it is a good plan to add water to half the amount of collodion, till it appears on the withdrawal of the plate from the bath to

have the appearance of crape, then to add the remaining half to that portion which was watered. On trying a plate it will be found that the film has lost the streaks, and is more dense than before. On the quality of the pyroxyline depends a good deal the amount of water that can be added.

THE SENSITIZING BATH.

The strength of the sensitizing bath is of the utmost importance in photography, as is also the purity of its constituents. The silver salt employed is invariably the silver nitrate, as it is the form most attainable in commerce, and can generally be procured free from impurity. Silver nitrate is readily soluble in its own weight of cold water, and in a still higher degree in hot water; but for the purpose to which it is to be put in the present instance, a far weaker solution is preferable. When iodides or bromides are used in the collodion, the utmost strength admissible is 50 grains of silver nitrate to each ounce of water, but for ordinary use the former proportion is too large, for this reason: silver nitrate in solution will dissolve up a certain amount of silver iodide,* the quantity depending upon the strength of the silver solution, and on the temperature. If the solution were not, therefore, saturated with the silver iodide, on the immersion of a collodion film the silver iodide would be partially or wholly dissolved out, according to the time of immersion. Now, it is easier to saturate a dilute solution than a stronger, and a variation in temperature causes a less marked difference with the former than with the latter. It is therefore evident that the less silver salt in solution the more likely it is that the solution will not show signs of under or over saturation of iodide.

The acidity or alkalinity of the bath is a condition to which it is necessary to give attention, the sensitiveness of the plate being dependent in a great measure on it. When simply iodized (with no bromide) collodion is used, the solution should be strictly neutral, or slightly acid, whilst with a bromized or bromo-iodized collodion it should be decidedly acid (with the former particularly it should be strongly acid). The reason of the different state of acidity in the two cases is not very easy to trace, but it is probably due to the different reaction that takes place when

* It will dissolve scarcely any silver chloride or bromide, hence it is unnecessary to saturate it with these salts.

silver bromide and iodide are exposed to light in presence of silver nitrate solution.

On the purity of the water employed is the sensitiveness of plate to a great extent dependent. Distilled water is naturally the most free from impurities, though even in it they are to be met with, unless great precautions are taken to eliminate them. When distilled water is not obtainable, water purified, as given in the Appendix, should be used, though if rain-water, *not* obtained from the roofs of houses, can be procured, it may be substituted with tolerable safety.

The following formula may be used for an ordinary negative bath when bromo-iodized collodion is used:—

Recrystallized silver nitrate	40 grains
Distilled water	1 ounce
Potassium iodide*	$\frac{1}{8}$ grain

Take a quarter of the quantity of water that is to be used, and dissolve the silver nitrate in it; then add the potassium iodide, or other soluble iodide. It will produce an emulsion of silver iodide, which will be partially re-dissolved on agitation. Next add the remaining quantity of water. This will cause a re-precipitation of silver iodide. After filtration the bath solution should be tested for acidity or alkalinity. Blue litmus paper should redden slightly after a minute's immersion. Should the red colour be produced immediately, a little sodium carbonate should be added till a slight precipitate is produced. This should be filtered out and the bath acidified with a few drops of a solution of nitric acid (1 drop of nitric acid to 12 drops of water). Acetic acid is sometimes recommended for acidifying the bath. If it be used, silver acetate is formed, which is injurious to sensitiveness and cleanliness of work, and cannot be eliminated by any convenient method. Should the test-paper refuse to redden, the nitric acid solution should be added. As a rule, if recrystallized silver nitrate be used the bath will require the addition of neither alkali nor acid.

Before taking a bath solution (or *bath*, as it will be hereafter called, for brevity) into general use it should be tested. This is

* Some prefer not to add any iodide to the bath, but to allow it to become saturated by work. If a plate be moved about continuously in a bath made minus the iodide, there need be no fear of pinholes. It should be stated that with a solution of greater strength than that given it is very difficult to avoid them when adopting this method of procedure.

best done by immersing in it a plate coated with collodion. When fully sensitized the plate should be placed in the dark slide, and then, for a second, *half* the plate exposed to white light. It should then be developed. A trace of fog on the part on which the light had not acted will denote that a slight addition of nitric acid is required, or that an organic or other foreign substance is present. The latter case will be treated of when the defects in negatives are under consideration.

DEVELOPMENT.

As already pointed out, the reduction of the iodide or bromide to the state of sub-iodide or sub-bromide may be invisible or latent. A developer is that agent which brings the chemical change to the cognizance of our senses. Pyrogallic acid is a body which is well known for its affinity for oxygen, as are the ferrous salts, the latter tending to become ferric salts, that is, to combine with more oxygen. When the oxidation of these bodies takes place in the presence of silver nitrate the metal is deposited. We will take the example of the iron salts when applied to the latent image to see how development is effected. The theory is based on the assumption that the silver sub-iodide or sub-bromide has an attraction for freshly-precipitated metallic silver, and its consequent deposition by the developer upon those parts acted upon by light. The reaction that takes place is thus:—

Silver Nitrate.		Ferrous-sulphate.		Silver deposited on the Subiodide.		Ferric-sulphate.		Ferric-nitrate.
$3AgNO_3$	+	$3FeSO_4$	=	$3Ag$	+	$Fe_2(SO_4)_3$	+	$Fe_2(NO_3)_3$

A little consideration will show that if this action take place the image must be principally *on the surface of the film*, and not in it. Experience shows that such is the case.

In the formulæ for developers it will be noticed that the addition of (acetic) acid is invariably included. If to a solution of pure ferrous sulphate (or pyrogallic acid) a solution of silver nitrate be added, it will be found that there is an almost instantaneous deposit of metallic silver. If, therefore, such a solution were flowed over an exposed plate which had free nitrate of silver on it, an immediate precipitation of silver would take place all over the film. The attraction of the sub-iodide of silver would be rendered void, owing to the rapidity of deposit.

With an acidified solution, however, the deposition would take place with greater regularity and less rapidity, and when sufficiently slow the sub-iodide would be able to attract all the particles of metallic silver as they were formed, and thus build up a metallic image. In practice the acid added is just sufficient to cause this gradual reduction of the silver. Heat increasing the rapidity of chemical action, it follows that in decidedly hot weather a larger quantity of acetic acid should be used than in cold.

It will also be noticed on the next page that different strengths of iron for the developing solutions are given. The stronger the iron solution the greater chemical power it will have, and the more rapidly it will decompose the silver solution. As a consequence, with a strong solution, all parts of the picture acted upon by light will immediately become nuclei for the deposition of silver, and the deposit will be of more even density than if a weaker solution had been employed; for with the latter those parts most acted upon by the light—*i.e.*, which had been most thoroughly converted into sub-iodide—having the most attractive force, would draw the deposit of silver to them, and the image would be much more intense at those parts than where the light had less strongly acted.

Acid developers may be divided into two great subdivisions: iron and pyrogallic acid.

Acid pyrogallic developers are now rarely used, since it was discovered that ferrous sulphate was the better reducing agent. When iodized collodion is employed without a bromide in solution, pyrogallic acid may still be utilized. It gives a very dense image, and is found useful for copying purposes, though a much longer exposure of the sensitive film to the action of light is required than would be necessary with the ferrous sulphate.

The usual formula for a pyrogallic acid developer for negatives and positives is as follows:—

Pyrogallic acid	1 grain
Glacial acetic acid	20 minims
Alcohol	*quant. suf.*
Water	1 ounce.

Since iron developers have been introduced there have been many modifications in the formulæ used. The following ten

formulæ are applicable to the production of negatives, and will be found of the greatest utility:—

No. 1.—Ferrous sulphate	... ...	10 grains
Glacial acetic acid	... ...	15 to 20 mns.
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.
No. 2.—Ferrous sulphate	... ...	30 grains
Glacial acetic acid	... ...	20 minims
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.
No. 3.—Ferrous sulphate	... ...	50 grains
Glacial acetic acid	... ...	20 minims
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.
No. 4.—Ferrous sulphate	... ...	20 grains
Copper sulphate	... ...	10 grains
Glacial acetic acid	... ...	20 minims
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.

The action of the different strengths of developers has already been pointed out, from which it will be gathered that in weakly lighted views without sunshine No. 1 would be used; in moderately bright light, No. 2; and in very bright light, or where the contrasts between the bright lights and shadows are very marked, No. 3 should be used to prevent an unnatural harshness of blacks and white; No. 4 is preferred by some photographers for landscape work. It gives clean and brilliant images, and the exposure is said to be shortened.

A good ordinary developer for general use, called "Wothly's Developer," is as follows:—

A perfectly saturated solution of the ferrous sulphate in water is prepared by adding six ounces of the iron salt to a pint of water.

No. 5.—Saturated solution of ferrous sulphate		2 ounces
Glacial acetic acid	... ...	¼ ounce
Alcohol	... ...	1 ,,
Water	... ...	16 ounces.

This developer keeps well, though it, like other solutions, loses its power after long mixing.

The double sulphate of iron and ammonia has been employed as a developing agent with great success. It gives great delicacy to the image, and has the property of keeping an unlimited time in solution without change.

No. 6.—Ammonio-sulphate of iron ...	... 25 grains
Glacial acetic acid	... 25 minims
Water	... 1 ounce
Alcohol	... *quant. suf.*

Formic acid is not a developing agent *per se*, but it seems to intensify the action of light on a sensitive film. Advantage has been taken of this property to add it to an iron developer.

No. 7.—Ferrous sulphate	... 30 grains
Glacial acetic acid	... 20 minims
Formic acid	... 10 ,,
Water	... 1 ounce
Alcohol	... *quant. suf.*

The special qualities of this developer are, that short exposure is required, and detail in the shadows is brought out.

Another developer, as given by Mr. Rangel, of Penmaen Mawr, is well worthy notice:—

No. 8.—Ferrous sulphate	... 2 ounces
Water	... 10 ,,

Add to this, when dissolved,—

Ammonia (·880) ... ... $1\frac{1}{2}$ to $1\frac{3}{4}$ drachms

This will deposit the iron as protoxide. Add to the solution containing the precipitate,—

Glacial acetic acid ... ... 2 ounces

This will redissolve the iron protoxide. Two to three ounces of this to be added to one pint of water for ordinary use. It may be used of greater strength if requisite.

This developer works very slowly, but very evenly, and is a very useful formula for beginners to work with.

It will be found advantageous to dissolve the protosulphate of iron in the water previous to the addition of the acetic acid or alcohol. As a rule, a red deposit of iron will appear; this may be filtered out after the addition of the acetic acid.

The addition of different organic substances to the developer

has been proposed by various photographers. The following are most to be recommended:—

No. 9.—Ferrous sulphate	...	...	...	20 grains
Glacial acetic acid	...	...	...	18 minims
Lump sugar	...	...	...	10 grains
Alcohol	...	...	...	*quant. suf.*
Water	...	...	...	1 ounce
No. 10.—Ferrous sulphate	...	...	...	20 grains
Glacial acetic acid	...	...	...	10 minims
Gelatine*	...	...	...	1 grain
Alcohol	...	...	...	*quant. suf.*
Water	...	...	...	1 ounce

The addition of these "organifiers," as they are popularly termed, have an effect on the colour of the image, and the silver is deposited more slowly. The sugar is found not to necessitate a longer exposure than if the ordinary developer be used; but the addition of the gelatine requires the action of light to be more prolonged to yield equivalent detail. Great density in a negative is yielded by all these organifiers, but generally at the expense of the half-tones. They are not, as a rule, to be recommended, excepting for winter work, for copying plans, or for producing great contrasts in a landscape.

In all cases the ferrous sulphate will, after a certain time, absorb oxygen from the atmosphere, and become a ferric sulphate. As ferric sulphate will absorb no more oxygen, it is evident that its developing powers are lost, and, in fact, it is found that it acts as a retarder. The change in the salt of iron is shown by a red, rusty coloration of the developer. This colour may become visible, in hot weather, two or three days after the solutions are mixed; in colder weather, a longer time elapses before the formation of any distinguishable ferric salt. A little ferric sulphate in the solution tends to keep the shadows bright, acting somewhat similarly to the acetic acid.

In time the *crystals* of the protosulphate of iron will decompose slightly, a yellowish powder forming on their faces. This is due to the formation of an insoluble oxide of iron. Allowance should be made in weight for this.

With a new bath, containing little or no alcohol, deve-

* The gelatine should be first swelled up by cold water. Afterwards it should be dissolved by heat, and then the acetic acid added to it.

lopers may be employed without the addition of any alcohol. After the bath has been worked for some time it gets impregnated with the collodion solvents, and then the alcohol, *quant. suf.*, must be added to cause the developer to flow without repulsion. And here it should be remarked, that pure spirits of wine should be employed, and not methylated. In the latter there is often dissolved resin, which, if present, must inevitably ruin a negative, as the development is rendered uneven.

It may happen that the acetic acid procurable is weaker than the glacial quality.* If sufficient of the weaker kind have not been added, or if the weather be very warm, a scum forming on the surface of the iron solution during development will appear, after which more acetic acid must be added till the developer works cleanly.

INTENSIFYING.

Any method of increasing the opacity of the developed image to the chemical active rays, either by changing its colour or rendering the deposit thicker, is technically called "intensifying a negative,"† and the agents used are called "intensifiers."

Either pyrogallic acid or ferrous sulphate may be employed with silver nitrate to cause an increase of density by thickening the deposit of the metallic silver. The reactions here are analogous to those of development, excepting that the metallic silver is the attractive matter instead of the sub-iodide. As the silver is gradually reduced to the metallic state, it is deposited on silver already reduced by the action of the developer.

This is one method of increasing the deposit, though there are others, such as treating the deposited silver with mercuric di-chloride, to form a double salt with it. By these a change in colour as well as in density is produced. Change in colour may be produced by substitution; as an example, if we treat the image with gold tri-chloride, we shall have the following reaction :—

$$\overbrace{3Ag}^{\text{Silver.}} + \overbrace{AuCl_3}^{\text{Auric Chloride.}} = \overbrace{Au}^{\text{Gold (deposited).}} + \overbrace{3AgCl.}^{\text{Silver Chloride.}}$$

* A method of estimating the strength of the acetic acid is given in the Appendix.

† Manifestly adding to the thickness of the deposit of a positive picture is useless. The colour may, however, be changed, in which case the action is termed "toning," and not "intensifying."

In other words, the gold displaces the silver. The equation, however, indicates that the image would be weakened in density, as one atom of gold takes the place of three of silver.

The following are formulæ for "density" intensifiers:—

No. 1.—Pyrogallic acid	... ...	... 2 grains
Citric acid	... ...	2 to 4 ,,
Water	... ...	... 1 ounce
No. 2.—Ferrous sulphate	... ...	... 5 grains
Citric acid	... ...	... 10 ,,
Water	... ...	... 1 ounce

No. 3.—An ordinary developer without alcohol.

Nos. 2 and 3 are usually employed in portraiture, and they are unusually efficacious in bringing out detail.

No. 1 brings up density more quickly than Nos. 2 and 3, and acts well for a properly exposed picture. Any of the above may be used either before or after fixing. To each a few drops of a ten-grain solution of silver nitrate should be added immediately before it is applied to the negative.

The next formula is for changing the metallic silver, after the image is fixed, to the state of iodide.

No. 4.—Iodine	... ...	... 1 grain
*Potassium iodide	... ...	... 2 grains
Water	... ...	... 1 ounce

After this solution has been applied to the film, any of the following may be used to cause the formation of a non-actinic colour.

Potassium permanganate intensifier (Mr. Wharton Simpson's).

No. 5.—Potassium permanganate	...	... 18 grains
Water	... ...	... 1 ounce

This is most easily applied by immersing the plate in a flat dish containing the solution till it appears of a yellowish colour throughout. The potassium permanganate is decomposed on coming in contact with the silver iodide, and parts with its

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* Iodine is very sparingly soluble in water; if potassium iodide be added, complete solution takes place.

oxygen, which combines with the silver; at the same time the insoluble binoxide of manganese is precipitated on the image.

No. 6.—Uranic sulphate ... ... 1 drachm
Potassium ferri-cyanide ... ... 1 „
Gold ter-chloride ... ... 1 grain
Water ... ... 20 ounces

The colour of the deposit by this intensifier is changed to a rich chocolate brown. The solution should be used in a flat dish.

No. 7.—*Mercuric di-chloride (corrosive sublimate) ... ... 20 grains
Ammonium chloride ... ... 20 „
Water ... ... 1 ounce

No. 8.—†Mercuric di-chloride ... ... 2 grains
Water ... ... 18 ounces

Add a solution (10 grains to 1 ounce of water) of potassium iodide till the red precipitate formed by its addition is on the point of becoming permanent.

With Nos. 7 and 8 the following solutions may be used, should sufficient density (as would be the case in copying plans) not be obtained. The reactions that take place when employing them are manifest without explanation.

No. 9.—Ammonium sulphide ... ... 1 ounce
Water ... ... 30 „

Or,

No. 10.—Potassium cyanide ... ... 5 grains
Water... ... ... 1 ounce

Silver nitrate to be added till a permanent precipitate is obtained. This last solution should stand a night before it is used.

No. 11.—Ammonia ... ... 1 drachm
Water ... ... 1 ounce

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* Mercuric di-chloride is only sparingly soluble in water; the addition of ammonium chloride causes it to dissolve readily.

† In this case No. 4 formula need not be used, as the potassium iodide in this plays its part.

There is but little choice between Nos. 5, 6, and 8; they are mostly suited to landscape negatives. No. 7 is used with good effect for pictures in which great density is required, or strong contrasts, particularly if followed by No. 9, 10, or 11; in both cases the high lights will be of a dense black or olive tint. From Nos. 4 to 11 all the solutions should be used after the image has been fixed.

When the sensitive film has been exposed and developed sufficiently to bring out the details of the image, and there is no tendency for the shadows to be "fogged" or veiled, intensification, by increase of density, should take place *before* fixing; if there has been over-exposure, *after* fixing. With an over-exposed picture, before fixing, an intensifier acts as a developer, and would cause fog; in most cases it is wise before using the intensifier, after fixing, to flood the plate with No. 4.

FIXING.

After the development of the latent image or picture formed upon the sensitive collodion film, the silver iodide and bromide are left unaltered, and, probably, the sub-iodides and bromides.

Looking at the reverse side of the plate (that which does not bear the film), the yellow colour of the iodide and bromide of silver will be apparent.

Were the unaltered iodides and bromides left in the film, a print taken from such a plate on paper in the ordinary manner would be found to be *nearly* a blank, as they possess almost as much power of preventing the passage of light as the reduced silver itself. There are certain chemical compounds which, in solution, are capable of dissolving them out of the film, leaving the metallic silver unchanged. These solvents are termed "*fixing agents*," and the operation of dissolving out the silver iodide and bromide is termed "*fixing* the image." Dismissing the chlorides of the alkalies and potassium iodide (owing to their imperfections as fixing agents), the first solvent of iodide, bromide, or chloride of silver that is to be noticed is sodium hyposulphite ($Na_2S_2O_3$).*

The chemical reaction of this salt upon the bromide being

* More correctly called the thio-sulphate.

similar to that upon the iodide, the case of the latter alone will be considered.

Silver Iodide.		Sodium Hyposulphite		Double Hyposulphite of Silver and Sodium.		Sodium Iodide.
$2AgI$	+	$2Na_2S_2O_3$	=	$Ag_2Na_2(S_2O_3)$	+	$2NaI$

The double salt is soluble in a solution of sodium hyposulphite; consequently the darkest shadows of the developed image will be rendered transparent through the removal of the iodide (and bromide) on the application of the sodium salt in excess.

The only other fixing agent that is in general use is potassium cyanide (KCy or K,CN). Its chemical reaction on the silver iodide and bromide is similar to that of the sodium hyposulphite, a double cyanide of silver and potassium being formed which is soluble in a solution of potassium cyanide.

Potassium cyanide* has also a slightly solvent power on finely-deposited metallic silver. If a test-tube be coated with a fine layer of metallic silver (see "Silvering Mirrors" in Appendix), it will be found that a strong solution of the cyanide will dissolve it completely after a short interval of time. From this simple experiment we learn the necessity of using a weak solution of this fixing agent, and allowing it to remain on the plate as short a time as possible.

Most photographers recommend the hyposulphite, in preference to the cyanide, as a fixing agent, owing to the latter's poisonous character and liability to eat into the half-tones. The colour of the negative given by the latter, by reflected light, is whiter, but by transmitted light browner, and, consequently, more non-actinic than if the former be used. For this reason, and also on account of the slightly diminished washing that is required to free the film from the traces of the fixing solution, the cyanide is here recommended as the agent to be generally employed. If ordinary precautions are taken, it need not prove hurtful to the operator through inhalation or otherwise; and if the film be washed *immediately* after the haloids of silver are dissolved out, there need be no fear of an attack on the half-tones. Sodium

* The potassium cyanide is a *deadly* poison, and great caution should be exercised in working with it. Its fumes are deleterious to the system, and if the solution come in contact with a cut or sore place in the skin, festering is liable to occur. Should, by any accident, any of the solution be taken internally, a draught of iron developer taken immediately will render it innocuous.

hyposulphite is to be avoided, on account of the mischief which even one drop of its solution causes to the bath.

Great care should be taken that no acid come in contact with the cyanide solution, as it is decomposed, and hydrocyanic acid vapour (prussic acid) is given off. The vapour is almost more dangerous than the liquid solution.

The following are the formulæ usually adopted :—

1.	Sodium hyposulphite	1 ounce
	Water	6 ounces
2.	Potassium cyanide	25 grains
	Water	1 ounce

VARNISHES.

Varnish is used to give protection to the delicate collodion film. It is simply a resin or resins dissolved in spirit of some description. When the solvent evaporates spontaneously, or by aid of heat, a thin layer of these resins is left, which gives the necessary hardness to prevent damage to the image in printing operations.

As a rule, it may be stated that the more colourless, the more suitable is a varnish for negatives.

The solvents used for varnishes are usually alcoholic. It is important that the specific gravity of the solvent should be greater than that of the alcohol of the collodion, as, were it otherwise, the image would be apt to be dissolved away with a portion of the film.

The proportions of the constituents of most photographic varnishes are, as a rule, trade secrets, but the following answer well :—

Alcohol	16 ounces
*Unbleached lac	2 ,,
Sandarac	2 ,,
Canada balsam	1 drachm
Oil of thyme or lavender	1 ounce

The resins should be dissolved in the alcohol by means of a water bath. The plate should be warmed as hereafter to be

* Bleached lac absorbs moisture, and tends to make the varnish crack.

described, heat aiding the hard and bright drying of the varnishes.

Seed lac	1 pound
Methylated spirit	1 gallon

The seed lac is allowed to remain in contact with the solvent two or three days, shaking it at intervals to aid solution. The clean liquid is then decanted off and thinned down (if necessary) to a proper fluidity.

Amber varnish, which is applied to a cold plate, is made as follows:—

No. 1.—Amber, in fine powder ...	1 ounce
Chloroform	16 ounces
Or,	
No. 2.—Amber	1 ounce
Benzole...	16 ounces

The amber should be heated in a closed vessel to a temperature of 570° Fah., when it will begin to soften. It can then be dissolved readily by the solvents.

In some cases but a few prints may be required from a negative. As a resinous-varnished film is difficult to wash off the glass, the following may be substituted for the spirituous varnish:—

Albumen	1 part
Water	3 parts

A dilute solution of gum-arabic may be used instead. In both cases the drying of the film should take place spontaneously. If the collodion film be dry, it should be wetted previous to the application of the albumen or gum solution.

MANIPULATIONS IN WET-PLATE PHOTOGRAPHY.

CLEANING THE PLATE.

It is advisable to grind the edges of the plate previous to taking it into use. This may be effected by a corundum file supplied by most dealers for the purpose. An ordinary fine file may be substituted, and it is then a good precaution to moisten it with a little turpentine, to prevent fine particles of glass*

* When subsequently cleaned they might cause scratches on the surface.

flying on the surface of the plate, and also to give a better bite. Failing these implements, the edge of one plate may be drawn against the edge of another, which will partially accomplish what is desired. The plate should be breathed upon to ascertain what state of chemical dirt it is in, and the tip of the thumb-nail passed over both surfaces to make sure which is the side polished in the manufacture. The unpolished surface generally feels gritty to the touch. If both surfaces feel rough the plate should be immersed in nitric acid and water, and allowed to soak for a few hours. It should then be washed under the tap, and allowed to drain. If there be many plates to drain, it should be remembered to keep them separate one from another. A good method is to stand them on edge on the floor, supporting one another, as in building the first storey of a card house. (It frequently happens, if the water contain chalk or other soluble solid impurity, that when the edge of one is allowed to rest against the surface of another plate, an opaque chalky mark is formed on the latter. This will entail the application of acid once more.) When drained, the tripoli powder solution should be applied to the plates with a tuft of cotton wool or old rag. A small quantity, sufficient to form a pool the size of a sixpence, may be poured on the plate and rubbed well over the surface. It is sometimes recommended to let this dry. It is believed, however, by the writer, that it is preferable to remove it off whilst moist, taking care that there is no arrest of motion before the surface appears dry. A diaper duster which has been well washed in plain water and then dried should be employed to rub off the cleaning solution.

A perfectly dry silk handkerchief or chamois leather should be reserved to give the final polish. (These should be well washed in soda or pearlash and water, well rinsed, and dried before use.) The motion of polishing the plate should be light, and in a circular direction. It should be remembered that this polishing generates electricity, positive on the plate, and negative on the rubber, and that electricity prevents the adhesion of the collodion film to the glass. This electricity may be dissipated by passing the handkerchief or cloth *very* slowly over the surface. This allows the re-combination of the two electricities. Sometimes it is useful to have a plate-holder on which to clean plates. There is none better than that described by Mr. J. Paget, which is as follows:—

"The cleaner . . . . consists of a board covered with two

thicknesses of flannel, held down by strips of wood on all sides except at C (fig. 1), where there is a thumb-hole. The strips

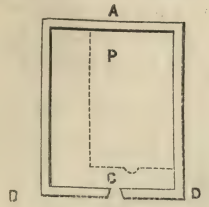


Fig. 1.

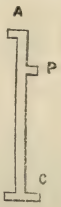


Fig. 2.

are of the same thickness as the glass, or are feathered down to that thickness at the inner edge, and enclose a space of the exact size of the glass, which is thus held firmly in its place. The strips are not under-cut. On the contrary side of the board from the flannel is fixed a strip of wood along the side B D, and a peg at P, both of which are shown in fig. 2, which is a section, through A C, of fig. 1. A hole is bored in the table at the distance P C from its edge, so that the cleaner is held perfectly fast by the strip and peg, without any assistance from the hand; and when a plate is placed in it the glass is, for practical purposes, as firm as if it were glued to the table, but yet it may be removed by the thumb in a moment. When part of the table can be spared for the purpose, the flannel may be laid upon it and the strips screwed through the flannel to the table, thus forming a fixed plate-cleaner of the very simplest possible construction."

Where different sizes of plates are used, ⌊ pieces, giving the proper dimensions, may be made as shown in the diagram.

Breathing on the plate indicates if the polishing be sufficient, but care should be taken that no small particles of saliva fall on it; the breath should leave the plate in a regular and even manner. The best position for allowing the breath to fall on it is from one end or side, keeping the mouth nearly on a level with the upper surface. The moisture from the breath should be fully dissipated before a plate is attempted to be re-polished. If this rule be neglected, transparent patches on the plate will be visible when breathed on again. It should be borne in mind that each plate has *two surfaces* to be cleaned.

Clean plates can be well stored in absolute contact with one another, provided they are tightly packed. If loosely packed,

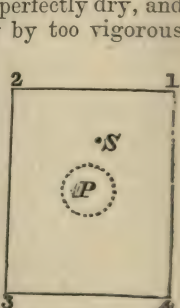
any small particle of grit that may fall upon them will be liable to cause scratches. Another method of storage is in plate boxes. This is not satisfactory, since all glass in contact with the air is liable to attract moisture and greasy matter. Clean blotting-paper is the best substance to pack clean plates with.

COATING THE PLATES WITH COLLODION.

It is inadvisable to coat a plate with collodion from a bottle which can contain more than five or six ounces, and this sized bottle should not be full, but should only be filled up to an inch or so below the neck. A larger one is unwieldy; and the collodion is apt to run down the sides of any bottle used when full. Convenient pouring bottles have been introduced for the dark room, but for out-door work the ordinary six-ounce bottles* will answer well. It is recommended that corks should be used in lieu of glass stoppers: the former clean the inside of the neck of the bottle from the thick collodion; whilst the latter are apt to stick fast, or to be forced out by the ether vapour when the temperature is raised.

If practicable, the collodion from the plate should not be poured back into the bottle from whence it came, as any dust contracted from the air would probably appear on the next coated plate; owing to the evaporation of ether, also, the collodion will become too thick for use before many plates are coated.

Dust from the plate should be removed with a broad badger-hair brush before coating. The brush must be perfectly dry, and care should be taken not to generate electricity by too vigorous a motion.



If a pneumatic plate-holder be used to hold the plate to be coated, it should occupy the centre of the plate as shown in the figure by P. The plate should be held at first horizontally, corners 1 and 2 being away from the manipulator. The collodion should be poured on to a spot S, the mouth of the bottle being as nearly in contact with the plate as possible, in order to avoid the formation of air-bubbles. S is fixed by the fact that the wave of collodion should reach corner 1 when such a

* A broad lip aids much in securing a uniform flow, and prevents the collodion running down the outside of the bottle.

quantity is on the plate as is just sufficient (or barely more) to cover the entire plate. The collodion wave should then be caused to flow to 2, next to 3, and finally the excess should be poured off at 4. The wave should be directed successively to these points by slightly tilting the plate. When the collodion is poured off at 4, the plate should be rather more tilted, till the excess has been got rid of, when it should be made to resume nearly an horizontal position, a slight inclination in the direction of 4, however, being preserved. A gentle rocking motion should now be given to the plate, but no grinding of the glass from the edges of the plate against the neck of the bottle should be allowed, or the small particles of glass would fall into the collodion, and appear as imperfections on subsequent negatives.

The collodion wave should not pass over the same spot twice, especially near corners 1 and 2. If it do, the almost invariable result is a thickening of the film at that place, and an appearance of a "curtain" by transmitted light. Should an air-bubble spoil the surface of the film, a second coating of collodion may be given. This will generally correct the fault.

When the collodion at 4 refuses to drop, and the film at 2 appears in a tacky state to the finger, the plate is ready for immersion in the bath. This "setting," as it is technically termed, is brought about by the partial evaporation of the ether and alcohol from the collodion.

Should no pneumatic plate-holder be at hand, the plate, if of moderate size, should be held by the thumb and middle of the first finger by corner 2, the extreme point of the corner alone being held by the cushion of the thumb. This manner of holding will enable the entire plate to be covered, and the disfiguring uncoated triangular portion at the corner 2, so often seen, will be avoided.

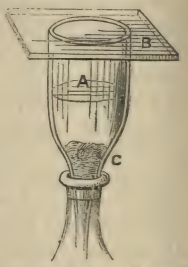
When the plate is of such dimensions as to cause the above method of holding the plate to be inconvenient, a valuable auxiliary is a bottle weighted with shot. A wooden ball covered with chamois leather has a rod inserted in it, and the other end is inserted in the neck of the bottle. To coat a plate with its aid one corner rests on the ball, and the opposite corner is held by the fingers, as before indicated.

In hot weather two minutes will generally suffice to cause setting, whilst in cold weather five or six minutes or more will be necessary. It is important that the right moment should be seized for sensitizing the plate, otherwise defects in the nega-

tive will present themselves on development or during sensitizing.

It has of course been supposed that the manipulator has examined his collodion to ascertain if it be free from small particles of undissolved pyroxyline or dust, also that no incrustation is on the neck of the bottle. The former will give plates which are specky in appearance, whilst the latter will speedily tell its own tale.

Collodion should, if practicable, be decanted from a larger bottle into the smaller pouring bottle, either by means of a syphon arrangement, as usually employed in the laboratory, or by carefully pouring off the top layer of the fluid. Collodion holders are to be obtained, holding from a quart upwards, which have a glass stopcock inserted about $1\frac{1}{2}$ inches from the bottom. With this arrangement the collodion can be drawn off free from sediment. It, however, frequently occurs that even decantation will not free the collodion from small light particles. When this is the case resort must be had to filtration. A convenient filter is to be obtained from Messrs. Powell, of Whitefriars Glass Works. A is a funnel with ground top, to which a glass plate, B, acts as a cover. Cotton wool is placed at C, being packed tolerably firmly, and it is then moistened with alcohol (·820). The collodion is introduced into the funnel, and is allowed to filter through the cotton wool into a bottle placed beneath.



SENSITIZING THE PLATES.

The glass plate having been coated, the next operation is the sensitizing of the film for the impression of the image. The corner of the plate from which the collodion has been poured off should be allowed to remain downwards.* When placed on the dipper in this position the plate should be *gradually* lowered, without stoppage, into the bath.

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* Some operators keep this corner upwards. This may cause a "curtain" of collodion at that part of the plate.

When once covered, the plate may be moved up and down (and also horizontally if the bath be large enough) till all greasiness, caused by the repulsion of the aqueous for the alcoholic solution, has disappeared. This will probably take two minutes in cold, and only one and a-half in warm weather.

When this motion of the plate in the bath is not attended to, it may happen that the alcohol may collect in rivulets on the surface of the film, preventing the access of the sensitizing solution to the bromo-iodides beneath them. (In this manipulation great care should be taken that the plate is kept entirely covered by the bath solution during the first minute, otherwise the film may become unevenly sensitized at the upper end, presenting an appearance of watered silk.) When, finally, the alcohol has become dissolved in the water, the beds of these rivulets would become less sensitized than those portions which have had access at once to the bath solution. The result might be a streaky negative. By washing the alcohol off, as described, no rivulets can collect; the film must become evenly sensitized, even before the total greasiness has disappeared.

When the greasiness can no longer be traced, the plate should be allowed to remain at rest for another minute and a half to three minutes, when, after a few more vertical motions in the bath, it may be taken out.

This last operation is generally performed in a hurried manner. Were more thought ordinarily exercised over every operation, many vexatious failures and loss of time would be avoided. A very little reflection must point out the utility of abstracting the plate *very* slowly. The capillary attraction of the liquid in the bath for the liquid on the plate will, if time be given, almost prevent the necessity of draining. The advantage of this force of nature is entirely lost by a rapid removal of the plate.

In taking the plate out, then, the dipper holding the plate should be very slowly raised, till a corner of the plate can be seized by the fingers of the disengaged hand. The top edge of the plate should be forced away from the dipper (if it be not made of silver wire), in order to prevent an accumulation of bath solution between the two surfaces. The plate is then raised till it is clear of the bath, and is immediately turned to the position it is to occupy in the dark-slide.

It will be remarked that different lengths of time for sensitizing are given below. To be able to understand the reason of these differences, the nature of the sensitizer, the proportion of

iodide to bromide in the collodion, the strength of the bath solution, and the temperature must be considered.

1st. With a strong bath solution a less time is required for fully sensitizing the film than with a weak one.

2nd. The greater the amount of bromide in the collodion the longer the operation will take, as the formation of silver bromide is much less rapid than is silver iodide.

3rd. The warmer the weather the shorter will be the time of immersion, as cold renders the access of the bath solution to the film more difficult.

A general rule for the length of time required for sensitizing ordinary commercial collodion is to immerse the plate three minutes in summer and six in the winter.

Before work is commenced, the bath solution should be freed of any deposit at the bottom of the bottle that may be apparent.* Filtration should not be resorted to more than is absolutely necessary. Decantation of the clear liquid from the sediment should first take place, and then the remainder (containing the deposit) may be filtered if required.

MANIPULATIONS AFTER SENSITIZING THE PLATE AND BEFORE DEVELOPMENT.

After the plate has been slowly withdrawn from the bath, it should be carefully drained on a pad of blotting-paper (three or four thicknesses at the least should be used), the end that will be lowest in the slide being pressed on to the pad. By this operation stains from accumulation of bath solution will be avoided.

The dark slide should be opened at the back, and held *nearly vertical*, and the plate put upon the silver wires after the drainings from former plates have been removed by blotting-paper. This vertical position is of importance, and one which in practice is often neglected. The silver solution is thus prevented from running back over the plate and causing markings.

The back of the plate should next be carefully wiped with a pledget of blotting-paper or rag, to remove any silver nitrate

* When filtration is resorted to, the honeycombed side of the filter paper should be next the funnel, and it should be moistened with distilled water before the solution is run through. Some filter papers contain contamination which is injurious to the bath, and should be tested. See Appendix.

solution which may have collected on the back. Should this precaution be neglected, horse-shoe markings (see "Defects in Negatives," page 47) on the developed image may be looked for.

Should the exposure be of considerable length, or if the time between placing the plate in the dark slide and development be likely to be long, a moistened sheet of blotting-paper should be placed at the back of the plate. This will keep the film moist through the evaporation of the water, and in a measure will prevent halation or blurring of the image if the blotting-paper be red.

Finally, a strip of blotting-paper should be placed at the lower edge of the plate, and just in contact with the film, to prevent the accumulation of the bath solution during exposure. The practice of letting the blotting-paper come between the film and the silver wires which hold the plate is to be condemned, for it should be recollected that the inner surface of the silver wires is made to coincide accurately with the surface of the ground glass; hence, if the film do not touch the silver wires, the whole focus of the picture is altered.

The slide should then be closed, wrapped round with a cloth if to be carried far, and held in the position it will occupy in the camera during exposure.

The view should, of course, be previously focussed on the ground glass of the camera. A few hints on the method of focussing may not be amiss.

The point of view having been chosen, and the camera placed approximately in position, the operator will pay attention to securing sharpness of each object to be portrayed. He will guess which diaphragm or stop to use, and having inserted it in the lens, will proceed to bring every point as nearly as possible into good definition on the ground glass.

Should an architectural subject be the subject of the picture, it will be necessary that the perpendicular lines should be strictly parallel. As a rule, if it be a near view, the camera will have to be tilted in order to bring in the whole of the subject; but before resorting to tilting, the front board of the camera which carries the lens should be raised to its full extent (*i.e.*, as far as the slot which secures the screw will allow). This will raise the image from the bottom of the ground glass, and allow the necessary amount of tilting to be given. When tilted sufficiently, the surface of the ground glass must be

brought perpendicular to a horizontal plane—that is, it should be plumb. If the glass be at an angle to the perpendicular, vertical lines which should be parallel in the picture will converge. It may here be remarked that the ordinary single lens will always give straight lines as curves towards the margin of a picture; hence architectural subjects should, as a rule, be taken with a doublet, or any non-distorting lens. A spot about one-third way from the centre of the picture and the edge should be selected, and that brought into sharp focus. If the diaphragm used be small enough, this will generally secure an equable focus throughout the picture; other points should then be selected and tried for focus; and that point which makes the focus generally sharpest should be selected as final. It should be noted that *the* object of interest should be especially sharp; a slight lack of definition in other portions being sometimes an improvement, as less distracting to the eye.

Should it be a landscape that is to be photographed, the swing-back need not be kept in a vertical position, as the perspective will not obviously suffer. In fact, it often happens that a large diaphragm may be employed, by judiciously using the swing-back to bring the foreground and distance into focus together, for the nearer the object the longer will be the focus, and *vice-versâ*. Hence by pulling out the top of the swing-back the lengthening of the focus is obtained, instead of by the employment of a small diaphragm.

Care should be taken that the screws fixing the camera to the legs are tight, and that the latter have a firm grip on the ground. In soft situations this is especially to be watched.

The object to be photographed having been properly focussed, the cap is replaced in the lens and the slide gently placed in the camera. The front of the slide is next raised, and the exposure commenced. (It is often advisable to place the focussing-cloth round the camera and over the dark slide, to prevent any possible access of light to the plate, except through the lens.) The grand rule for timing the exposure may be stated to be—"*Expose fully for the details in the deepest shadows; the high lights will take care of themselves.*" During the time of exposure never touch the camera or legs with the hand; it should be remembered that the human body vibrates, and that these vibrations will be communicated to the camera.

Should the picture happen to be taken outside the studio in windy weather, lulls must be watched for, and the cap cautiously replaced on the lens during the gusts. A heavy stone suspended by a string from the top of the camera-stand will often check oscillation during exposure.

The same precautions in carrying the dark slide to the developing room or dark tent should be observed as those already given for carrying it to the camera.

DEVELOPMENT.

Having filtered the developer, if requisite, and placed the necessary quantity in the *clean* developing cup, the plate should be taken out of the slide. Care must be taken that in no case the plate is laid horizontally, or in any other direction different to that in which it has been carried from the camera, though the angle of inclination may be much modified. The *developer is then with an even motion swept* without stoppage (the rim of the cup almost touching the film) over the plate till the latter is completely covered. As little of the solution as possible should be allowed to flow over the edges.*

The writer prefers to keep the long edge of the plate next to him, whilst the corner of the plate where any drainings may have accumulated is away from him. The plate is held with a *small* inclination downwards away from the body, and then the developer is applied as above.

The developer is worked round and round to each corner of the plate in succession till the image is fully out. If properly exposed, the image will take some half minute to appear fully, and the deepest shadows alone should remain of the yellow tint due to the unaltered iodide and bromide of silver. An under-exposed picture will take a long time to bring out, whilst one over-exposed will flash out at once, and, unless the developer is immediately washed off, will appear to fade away and give a flat and fogged negative. A properly exposed and developed picture should, by reflected light ("looking down on the plate"), appear as a well-defined and graduated image lying

* If the developer flow over the edge of the plate, it carries much of the free silver with it which is necessary to give density to the image. Some writers advocate the loss of this free silver. I cannot advocate it from theory or experience, excepting where too much vigour in the resulting picture is feared.

on a ground of silver iodide; whilst, by transmitted light ("looking through the plate"), every detail should be visible both in shadow and high light. With proper exposure the developer may stay on a negative for a long time without injury.

A plate-holder* is recommended for holding the plate during development. If not at hand, the corner must be held as described in the article on Coating the Plate (page 30), or else the plate may be supported in the centre by the tips of the fingers; though this procedure is not recommended, as the warmth of the fingers communicating itself to the glass is apt to cause uneven development at those places. In developing large plates without the aid of a plate-holder, a support similar to that given at page 31 may be employed.

Some skilful photographers develop their pictures in a glass tray slightly larger than the plate. The plate is carefully placed at the bottom, and the developer allowed to flow over it in one unbroken wave. The development of the image is watched through the glass bottom of the dish.

The following maxims are worthy of attention:—

1st.—Always have a weak and a strong developer in the field and in the dark-room.

2nd.—Think well as to which will answer your purpose the better, remembering that with a strong developer contrasts of light and shade are subdued, whilst with a weak one they are increased.

3rd.—Use your developer before it attains the reddish-brown colour, and do not use methylated in place of pure spirits of wine.

4th.—The less acetic acid used the more harmonious will be resulting picture.

5th.—Reject a negative which is either under-exposed or much over-exposed.†

INTENSIFICATION.

Practice alone can give the operator a knowledge of the exact amount of density required in a negative. Pictures are

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* Not that one which has been employed for holding the plate during coating with collodion.

† It is too often the case that time is wasted in attempting to patch up a worthless negative. If the image appear unsatisfactory, and it be possible to expose another plate, obey Rule 5.

often spoilt by bringing up the half-tones to a nearly equal density with the highest lights. It should be recollected that the printing power of a negative not only depends upon the *quantity* of deposited silver, but also upon its *colour*. If a negative, on account of its density and colour of *deposit*, allow the *deepest shadows* to print to a depth verging on bronzing, and at the same time leave the *highest lights* white, or very nearly so, any further intensification will be detrimental.

The operator's judgment must decide whether he should use those intensifiers which cause increased deposit, or those which merely cause change of colour.

Should the former be decided upon, and if the picture has been slightly over-exposed, it is well to stop all further danger of development by treating it with a weak solution of potassium iodide and bromide for a minute or two. This will completely check all further action excepting that of intensification. A more common method of treatment is to fix the picture first and intensify afterwards.

Intensification before fixing should be conducted as laid down for development. The intensifier should be flowed over the plate first, next the silver nitrate dropped into the cup, and then the intensifier from off the plate poured back. By this means a perfect mixture of the two is obtained. The intensification should proceed till the requisite density is arrived at, or till the solution becomes turbid if it be of iron, or deep brown if of pyrogallic acid. In the latter case a fresh portion should be taken, and the intensification proceeded with till complete.

When intensifying with pyrogallic acid, it will be found advantageous (*should the exhausted solution not be turbid*) to leave a little of the brown solution in the cup, and then add the first to it. A more even and satisfactory action seems to be set up by this artifice.

In landscapes and in portraits the highest points of light alone should appear opaque before fixing.

If it be necessary to obtain more photographic opacity after fixing, it is advisable to use the iodine solution first (No. 4, page 22).* This tends to prevent a red deposit forming on the shadows when the iron or pyrogallic acid formulæ are used.

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* If the negative have dried before it be intensified, the edges should be varnished with Bates's Black Varnish, or run round with india-rubber solution (see page 55), to prevent the film leaving the plate.

This operation may proceed in diffused light. It is more difficult to decide on the printing qualities of a negative which is intensified by change of colour. Practice alone can enable the operator to be sure that he has obtained the necessary opacity to the actinic ray.

FIXING THE NEGATIVE.

If sodium hyposulphite be used, the plate may be immersed in it in a dipping bath or flat dish, or else by flowing the solution over it; if potassium cyanide be used, the latter mode of applying the fixing agent is advisable, and care should be taken to wash the plate directly all the unaltered silver iodide and bromide is dissolved. The absence of these salts may be known by reversing the plate, and noting if the yellow semi-opaque colour has totally disappeared from the shadows.

After *development*, *intensification*, and *fixing*, the plate should be *well washed*.

DRYING AND VARNISHING THE NEGATIVE.

The plate may be allowed to dry either spontaneously or by the application of heat; but in no case should both processes be employed. Quick drying, as before stated, gives an increased density to the image; thus, if a negative be dried partially by one and partially by the other, the gradations will be false.

A neat appearance is given a negative when dry, and before varnishing, by scraping off the film round each edge of the plate to a distance of about one-eighth of an inch. This also prevents damp penetrating between the film and the glass plate, as the varnish coats both the margin and the film.

Before applying the varnish (see page 27), the plate should be warmed.* The varnish should then be flowed over like collodion, the same gentle rocking motion being preserved as in coating a plate. When the excess has run off, any varnish collected at the lower edges may be removed by pressing them down on a pad of blotting-paper. The plate should now be thoroughly heated. When cool it is ready for the printing operations.

The best source of heat is a Bunsen burner or paraffin lamp,

* The soft part of the back of the hand, between the thumb and first finger, should just *not* be able to bear the heat of the plate.

the plate being moved briskly over the top of the chimney; the next is an ordinary fire; and the worst, the flame of a spirit lamp. In using this last, after applying the varnish, great care is requisite to prevent the flame setting fire to the spirit.

It sometimes happens that the film tends to peel off and split whilst drying. The application of stale beer to the negative will prevent this fault. A weak solution of gum has been recommended, but gum has the property of absorbing moisture; it swells, and causes the film to crack, the varnish being unyielding. Gum should, therefore, not be used unless the negative is required to last but for a short time. A solution of albumen will answer equally as well as the beer.

DEFECTS IN NEGATIVES, ETC.: THEIR CAUSES AND REMEDIES.

In the foregoing chapter the bare manipulations necessary for taking a wet-plate negative have been discussed, and no notice, or very little, has been taken of the defects that are likely to be met with at some time or another. This chapter will be devoted chiefly to a narrative of the defects, and the remedies to be applied.

DEFECTS CAUSED BY THE GLASS PLATES.

If the negative appear to be fogged in certain places while the remaining portions are bright, a dirty (*i.e.*, not chemically clean) plate may be suspected. If a scum be apparent at the reverse side of the plate the suspicion is confirmed. The dirt may arise from improper cleaning of the plate with the tripoli powder or whitening (see page 28), or else from compounds unattacked by these solutions, such as the remains of corrosive sublimate (mercury dichloride) used in the intensification of a previous negative on the same plate.

The remedy in the first case is apparent; in the last case the plate should be washed well with water, and then steeped in nitric acid and hot water (one ounce to the quart is sufficient), and allowed to soak twenty-four hours. This will probably cure the evil, after the plate has been thoroughly rinsed with cold water, and cleaned in the ordinary manner. Sulphuric acid and potassium dichromate, or a solution of cyanide, have been recommended. Practically, they do not appear to have any advantage

over the nitric acid. Should this treatment fail, the plate may be coated with a solution of albumen as described hereafter.

Circular and straight transparent markings are sometimes met with when a negative has been taken on a plate that has been put away as clean. Their occurrence leads to the suspicion that the plate has since become damp, or that a damp silk handkerchief has been used in polishing, or, perhaps, that one has been used which has been improperly washed with soap, and has not been thoroughly rinsed out.

Sometimes the collodion sets in streaks from one corner or edge, forming large ridges and furrows on the plate, which become only too apparent on sensitizing. Chips in the edges of the plate will cause this defect. The collodion clings to inequalities, and by molecular attraction small pools are formed, which finally run over on the plate, and cause the ridges. The remedy for this defect is to re-grind the edges of the plate carefully, or, if only one edge be defective, to pour off the collodion towards that edge.

Opaque streaks in a negative are usually due to scratches in the surface of the plate. There is no cure for this defect—the plate must be rejected. If round transparent markings of the size of a pin's head be apparent in the negative, when the glasses employed are new, a crystalline deposit on the surface of the plate must be looked for.

DEFECTS CAUSED BY THE COLLODION.

When the plate is taken out of the bath, should the film appear much less opaque at the end at which the collodion was poured on than at the lower end,*—1st, the collodion has been allowed to set too long; 2nd, it has been prepared with too highly-rectified solvents, and ether in excess; or, 3rd, there is alcohol in excess, causing the plate to dry at the top before it has set at the bottom.

The remedies are, in the first case, apparent; in the second, leaving the bottle of collodion unstoppered till the necessary amount of ether has evaporated, making up the quantity with alcohol, and then adding one or two drops of water to the ounce;

* The portion of the image developed on these semi-transparent parts would be very feeble.

in the third case, the addition of a drachm of ether and a quarter of a grain of iodide of cadmium to the ounce of collodion.

The next defect that may be noticed is the collodion showing opaque markings, after sensitizing, at the corner whence it was poured off. This may be caused by too much iodide and bromide in the collodion, in which case, plain collodion should be added; or, it may be caused by the collodion being too alcoholic. If the film be allowed to set longer before immersion in the bath, it is probable the fault will be corrected.

Should the defect noticed in the last paragraph be exaggerated, the iodide from the film leaving the plate almost completely in places, the collodion is either not sufficiently porous, or else has been too highly iodized. In the first case water may be added little by little, and in the latter plain collodion.

Films sometimes refuse to "work," though they appear dense and creamy. The finger should be rubbed lightly along one corner of it, and if the silver bromo-iodide rub off, both the above remedies may be applied.

When the collodion leaves the plate with the bromo-iodide it has not been allowed to set sufficiently before immersion in the bath; the water in the bath acts on the pyroxyline before it becomes gelatinous (from the evaporation of the ether and part of the alcohol), and the cotton is precipitated.

Curtains on the film have been noticed in "Coating the Plate" (page 31), and the reason given of their existence. The cure was also suggested.

Markings in the film having the appearance of a fine network or crape arise from the use of too gelatinous a sample of collodion, or from a strong cadmium bromo-iodizer.* The remedy, in the former case (in which the plain collodion "per se" gives this structure), is to add a more limpid sample to it. If caused alone by the latter, keeping will probably rectify the evil; whilst if the result be from both causes, the addition of a limpid alkaline iodized collodion is recommended.

Should the developed image appear weak, and the film be opalescent, it is probable, if the collodion be in fault, that it is deficient in pyroxyline, either from sufficient not having been at first added, or from a deterioration due to age.

A lack of half-tones in the image may be due to the use of a collodion whose pyroxyline has been made at too high a tem-

* Solvents too largely diluted with water may also cause this defect.

perature, or by the iodine in it being liberated to excess.* The defect suggests the cure.

Should the film split on drying, it is probable that the collodion used contained too much ether. Pyroxyline made with too strong acids will also cause the evil. Mixing with another sample of collodion will probably be the best cure.

If the pyroxyline be made in weak acids, the film will generally adhere to the plate; but if it be of a gelatinous kind it may leave it.

An under-iodized collodion will cause the developed image to appear flat and lacking in density. Try adding an extra grain of iodide of cadmium to the ounce. If the collodion be too highly *bromized*, and remain in the bath but a short time, the same defect will occur.

Opaque comet-like spots are sometimes to be met with in the developed picture. They usually arise from dust in the collodion, due to small particles of undissolved pyroxyline. The best remedy is to have a stock bottle for the collodion, and allow it to stand perfectly quiet. The upper portion may then be syphoned off and filtered (page 32).

DEFECTS CAUSED BY THE SENSITIZING BATH.

A line across a plate, seen after sensitizing, denotes a stoppage in the motion of immersion.

Lines in the direction of the dip are generally caused by the bath being too alcoholic. (Each time a plate is immersed the water absorbs a percentage of ether and alcohol.) The excess may be removed by raising the temperature of the solution to about 200°. The alcohol is driven off in vapour at that temperature, whilst the aqueous solution remains behind. The solution may also be boiled down to half its original bulk, and be made up to the proper strength by the addition of purified water. These lines may also occur through the use of collodion with a very repellent film. This may be remedied by shaking it up with sodium carbonate, and decanting from the residue, or by adding to it one or two drops of water.

A scum on the film may be caused by the use of a bath containing too much silver nitrate. Test its strength, and add water, if requisite, filtering out the iodide that may be precipitated.

* Shown by the deep colour it assumes.

It may also be due to the use of a collodion too highly bromo-iodized; if this be the case. the latter should be mixed with a small quantity of plain collodion. Silver acetate in the bath is likewise a cause of scum. It should in all cases be filtered out, or be removed by drawing a strip of clean blotting-paper along the surface of the bath solution.

A bath carefully used will rarely get out of order. Sometimes, however, by accident, it may become contaminated by foreign matter, and the negatives be poor, flat, and, in some cases, useless, through fog on the shadows. To render the bath fit for work, resort should be had to the action of sunlight (after neutralizing the acid with sodium carbonate or freshly precipitated silver oxide), as explained in the purifying of water (see Appendix). This is the best and, probably, the only legitimate cure for a bath that gives negatives of the foregoing description, except evaporating the solution to dryness and fusing the silver nitrate. The addition of potassium permanganate has also been recommended. It is at the best a doubtful cure.*

Should these means fail, the best plan to adopt is to precipitate the silver, and make a new bath from it, as given in the last chapter.

There may be another cause of flatness in a negative, viz., the bath being below its proper strength of silver nitrate.†

Transparent pinholes on a negative, after fixing, are caused either by dust, or through the bath being over or under-iodized. Should they be caused by the bath being *over*-iodized, a granular appearance will, by reflected light, be visible on the surface of the plate. The granules are silver iodide separated from the bath. The remedy for this is to take one-fourth of the bath solution and dilute it with three times its bulk of water. This will cause an emulsion of iodide, which can be filtered out. Solution may then be made of proper strength, either by boiling down, or by the addition of fresh crystals of silver nitrate. Another method more recently proposed is to add a few drops of hydrochloric (muriatic) acid to the solution with constant agitation. This carries down the excess of iodide along with the chloride, but leaves the bath acid from liberation of nitric acid. The addition of barium nitrate has also been recommended

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* Permanganate, fifteen grains; water, one ounce. This solution to be added to the bath till a faint permanent pink colour is given.

† A method of testing the strength of the bath is given in the Appendix.

as a permanent cure for over-iodizing. In the experience of many operators it answers admirably. It has one defect, however, which is that ferrous sulphate precipitates the barium as insoluble sulphate. This causes a slight veil to be apparent over the image, but varnish in a great measure restores the transparency. The following solution is recommended :—

Bath solution	... 1 ounce
Barium nitrate	... 5 to 10 grains

The bath should be filtered after the addition of the barium salt is made, if necessary. If the plate, after fixing, show signs of pinholes without the excrescences being previously visible, the bath is under-iodized. In this case more potassium iodide should be added.

Stains on its lower end may arise from the plate not being properly drained; or, if properly drained, from the plate being reversed from its proper position whilst in the dark slide.

Fog may be caused by the bath. A separate article will be given on this defect, its causes and cure.

When the bath is too acid, hard negatives, wanting in detail, often result. The acidity may arise from the use of collodion which has liberated iodine, and acidified the bath solution.* This may be remedied by adding an alkaline solution to the bath. Hardness may also be due to the development, through causes which will be stated.

Transparent flashes and curtains are generally caused by the free silver nitrate drying on portions of the plate, owing to the length of time elapsing between taking the plate out of the bath and developing it.

Negatives are particularly liable to this defect if the bath be at all old and alcoholic. Careful draining, using damp blotting-paper at the back of the plate in the slide, and other obvious precautions, should be taken.

Opaque markings, taking the form of lines, may occur through the bath solution collecting and running down the plate, particularly if the plate be not fully sensitized. The rivulets of bath solution complete the sensitizing of the plates in those portions alone, hence the image is stronger at those parts. The cure is plain.

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* The iodine liberated combines with the nitrate of silver to form iodide of silver, and liberates, together with other products, nitric acid.

DEFECTS CAUSED BY INTENSIFYING AND FIXING.

The chief defects that arise through intensifying are thos which may also occur in development. Fog and a red deposi are chiefly to be anticipated. The former may occur before fix ing if the pictures be over-exposed; the latter, both before an after fixing, by the addition of too much free nitrate of silver t the intensifier; or again, after fixing, by the imperfect washin of the film before the intensifier is applied. The red stain wi generally yield to

Glacial acetic acid...	1 ounce
Water	1 ,,

Fog may be reduced as given at page 50.

It should be noted that the larger the amount of silver adde the more rapid will be the intensification; but the half-tone will not be brought up proportionately to the high lights. Th smaller the quantity of silver used, the greater will be th comparative force given to them, and the longer time it wi take to get proper printing density.

Thus, a negative lacking in contrast may be corrected by usin an intensifier with large, and one too rich in contrast with sma doses of silver.

The defects caused by fixing are few in number: the chief is that caused by the potassium cyanide eating away the half-tone or the washing off being too long delayed. If strong cyanide b used, and it be allowed to stop in its flow over the plate, a li of weak density may become apparent. A film splitting aft varnishing may often be traced to the use of sodium hyposulphi as a fixing agent, and a subsequent imperfect washing.

DEFECTS CAUSED BY VARNISHING.

Several defects may arise in varnishing. First, and mo serious, the film may dissolve away. This is caused by th solvent used in the varnish being stronger (*i.e.*, of less specifi gravity) than that employed in the collodion. The addition of small quantity of water may effect a cure, or varnishing the pla cold, and *then* heating it, may answer in some cases.

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Should a transparent mark show across a negative immediately after varnishing, it is probable that the solvents are *slightly* too

strong, and that the varnish has not been allowed to flow over the film without stoppage. The cure suggests itself.

Ridges in the varnish on the film *may* denote that too much of the solvent has been allowed to evaporate by repeated applications to other plates. Add more spirits of wine (·840 methylated will answer). Ridges may also arise through rough edges of the glass, or from dust on the film. Varnish may crack through swelling after it has been applied to the film, and give blisters. This may be caused by bleached lac having been used.

If from any cause it should be desired to remove the varnish from a film, it should be subjected to the vapour of alcohol; or weak alcohol may be flowed over the plate five or six times, warming the plate as if for varnishing between each application. This will dissolve it off, and leave the plate in its original state, after which it may be re-varnished. Varnish may also contract; this is probably through the use of copal in its composition. Should the varnish dry matt, it is probable that sufficient heat has not been applied after coating the film with it. If it dry matt in parts, it is probable that the preliminary heating of the negative has been unequal.

Other small defects may sometimes be noticed. A little thought will generally trace their cause, and suggest the remedies.

DEFECTS CAUSED BY THE DARK SLIDE.

Should it happen that at one or more corners of the plate the silver is reduced on development, so as to cause opaque marks, the slide should be examined. The evil may arise through the wires which support the plate not being made of *pure* silver. A coating of varnish applied to them will prevent future mischief.

Opaque streaks seen after development, running from one corner, may possibly denote the ingress of light into the slide.

Transparent marks of the size and shape of a pin's head, with a very small opaque dot in their centres, may show that dust has fallen from the front of the dark slide on to the film. The inside of the slide should be carefully wiped out with a damp cloth. Similar spots may arise from the use of collodion made with pyroxyline prepared with dilute acids (see page 8), though in this case the central dots are generally not visible.

FOG ON WET-PLATE NEGATIVES.

Fog or a veil over a negative being one of the commonest defects met with, it may be useful to point out the method to be adopted systematically to detect its origin.

Over-exposure in the camera is one of the most common of its causes, particularly when working with newly-iodized collodion.

The contamination of the silver nitrate bath by organic or foreign matter will also give rise to it. It is easy to account for organic matter in the bath, the dust and other impurities that float in the atmosphere of the dark room being one source. Distilled water may also contain it, as ordinary stills are frequently used for other distillation than that of water. A bath made of impure gutta-percha* may also account for its presence, as will the wooden case of a glass bath, provided the bath solution happen to touch the wood whilst being poured in or out. In all these cases sunning the bath solution, or evaporating it down to dryness, are the most effectual remedies. Potassium permanganate may be employed as a corrective, but, as before stated, is not recommended.

Alkalinity of the bath will be certain to cause fog. The cure in both cases has been given, under the head of the "Sensitizing Bath" (page 15).

Diffused light in the dark-room, in the camera, or through the lens, will cause a foggy picture.

Vapour of ammonia, the product of the combustion of coal-gas, and sulphuretted hydrogen, are also inducive of fog. All these vapours may be detected by their smell.

The omission of the acetic acid in the developer (or the presence of too small a proportion) will cause the evil, as also a very high temperature in the dark-room.

Many filter papers contain iron, and other impurities, which may induce fog.

TRACING THE CAUSE OF FOG.

Should a negative appear fogged, a fresh plate should be tried, and reduced exposure should be given; if this fail to effect a mitigation of the evil, the bath should be tested for acidity or alkalinity, as shown at page 15. If the bath be of the right acidity, a plate should be sensitized and kept for two or three

* Gutta-percha is often adulterated with magnesium, salts, &c.

minutes in the dark-room. It should then be developed, and the presence of fog will indicate (supposing no hurtful vapours be present) either organic matter in the bath, or diffused light in the dark-room. Another plate, similarly treated in a really dark room, will show if it be due to the latter cause. If, however, it be proved that neither the bath nor the dark-room be in fault, another plate should be sensitized and placed in the camera. The front board of the slide should be withdrawn as usual, but the cap of the lens should not be removed. The plate should next be flowed with the developer in an absolutely dark room. If fog be still apparent, the bath is at fault. If the bath be new, it may be that there are vapours present which cause fog.

If fog be present, diffused light is admitted into the camera; if absent, it is probable that the fogged negative was due to the bad lighting of the subject, or to diffused light through the lens, as in the case in which the sun is allowed to shine directly on the glasses.

To render a slightly-fogged negative fit for printing, a solution of iodine and potassium iodide (page 22, No. 4) may be applied to the film, and the silver iodide dissolved away with potassium cyanide. With one or more applications of the iodic solution the veil may often be removed without injuring the density of the negative. Another method of reduction is by using the following in lieu of the iodic solution:—

Saturated solution of ferric chloride	... 1 drachm
Water	... 1 ounce

This is floated over the negative, and, after washing, the cyanide is applied. By this method the deposit on the shadows seems to be more attacked than that on the lights; it is consequently to be preferred.

$$\overbrace{[Fe_2Cl_6}^{\text{Ferric Chloride in Solution.}} + \overbrace{2Ag}^{\text{Silver in the Film.}} = \overbrace{2AgCl}^{\text{Silver Chloride in the Film.}} + \overbrace{2FeCl_2]}^{\text{Ferrous Chloride in Solution.}}*$$

The silver chloride is dissolved away by the fixing agent. Very dilute nitric acid may also be applied to the film, but this requires very delicate handling. The acid should be diluted with ten times its bulk of water.

* It seems as if subchloride was also partially formed by the ferric chloride. The general equation, however, holds good.

POSITIVE PICTURES BY THE WET PROCESS.

With negative pictures the great desideratum is to obtain as white a deposit of silver as possible, that efficient contrast between the black or dark backing may be obtained. The bath itself is not required to be so strong, but the collodion may be the same as that employed for negative work.

The formula for the sensitizing bath is—

Recrystallized silver nitrate ...	... 300 grains
Nitric acid	... $\frac{1}{4}$ min.
Water	... 10 ounces

The bath is prepared precisely as given for the negative bath at page 15.

The following developers are efficient: the pyrogallic acid developer (on page 17), and

Ferrous nitrate	... 110 grains
Ferrous sulphate	... 60 ,,
Nitric acid	... 20 min.
Alcohol	... *quant. suf.*
Water	... 4 ounces

The ferrous nitrate may be prepared by taking barium nitrate 130·5 grains, dissolving it in 2 ounces of water, and adding to it a solution of 76 grains of ferrous sulphate in 2 ounces of water. A precipitate of barium sulphate falls, which must be filtered out, and in the solution are 110 grains of ferrous nitrate. The nitric acid should be dropped carefully in the 20 minims, being previously diluted with half an ounce of water. The alcohol is then added, after the 60 grains of sulphate of iron have been dissolved.

The nitric acid causes the silver to deposit with a white lustre by reflected light, and this developer is consequently very effective for the purpose required. The image should be fixed with the ordinary cyanide fixing solution given at page 26.

When the picture is taken on a ferrotype plate nothing remains but to varnish it with ordinary colourless varnish; but it must be recollected that in this case the image is reversed.

When a glass plate is employed the film side may be varnished with Bates's Black Varnish, in which case the image will appear in the natural position of the object.

A good black varnish is made as follows :—

Asphaltum...	4 ounces
India-rubber solution, as supplied for telegraphic purposes	1 fluid ounce
Benzole	12 ounces

The manipulations in positive pictures are similar to those for negatives, and need not be described again. Ferrotype plates (which are thin iron plates enamelled or japanned with a chocolate brown medium) are cleaned with a little *dilute* potash, followed after with dilute nitric acid, and a final wash in distilled water. They are then allowed to dry, and rubbed over with a chamois leather or silk handkerchief, if requisite.

DRY PLATE PROCESSES WITH THE BATH.

There are certain manipulations common to all dry plate processes, and it is proposed to detail them here instead of repeating them with each process.

A plate may be edged with albumen, gelatine, or india-rubber; or the surface may receive a fine coating of any of these bodies in order to cause adhesion of the film to it during development and subsequent treatment. All of these bodies adhere firmly to glass, and also to collodion, and the fine layer or edging the plates receive acts similarly to a mordant in dyeing. It is not always absolutely necessary when working dry plates to give this substratum, but it is, as a rule, advisable.

When it is determined to adopt this plan of securing adhesion of the film, the plates should not be polished by the silk handkerchief. It is better to soak them first in potash, then in a dilute solution of nitric acid, and finally to rinse them thoroughly in pure distilled water. They should then be placed in a rack on clean blotting-paper, and be allowed to dry spontaneously. If albumen be employed as the substratum, the following solution should be made up :—

Albumen	1 ounce (white of one egg)
Water	50 to 100 ounces
Liquor ammonia	5 drops*

* Three or four drops of commercial carbolic acid may be substituted for the ammonia.

The albumen and water should be well shaken together in a bottle for five minutes, and then filtered through fine filter paper or well washed tow. The funnel should be lowered nearly to the bottom of the beaker into which the albumen is filtered, to prevent the formation of air-bubbles.

Another formula is here given for the dried albumen as supplied by photographic chemists :—

Dried albumen	...	...	...	50 grains
Water ...	...	...	...	50 ounces
Liquor ammonia	...	...	...	5 drops

The albumen may be dissolved by the aid of heat not exceeding 120°. The solution is filtered in the same manner as the above.

The most convenient method of applying albumen is that employed by Mr. Valentine Blanchard. A brush is made of swan's-down calico, as follows :—A strip of glass, about six inches long by two broad, should be procured, and round one end should be attached, by thread or india-rubber band, a double fold of swan's-down calico. This brush should be dipped in the albumen, and the excess squeezed out against the beaker. The plate should then be brushed smoothly down the surface in parallel lines to within one-eighth of an inch of its edges, set up to dry on blotting-paper, and protected from dust. When dried (which it should be spontaneously), the plate will be ready for the collodion.

Some prefer to flow the plate with the albumen solution. This is best done on a plate which has been well cleaned but not polished, and which has been subsequently moistened with distilled or rain water. Whilst still wet the albumen should be flowed over the surface as in coating a plate with collodion, and the surplus fluid returned to the stock bottle through the filter. If this plan of giving a substratum be adopted, the solution should only contain fifty ounces of water to one ounce of albumen.

Another substratum, which gives even better results than the albumen, is the following:—

Sheet gelatine	75 grains
Distilled water...	60 ounces
Ammonia	$\frac{1}{4}$ ounce

The gelatine should be first softened in 30 ounces of cold water, and then dissolved by adding the remaining 30 ounces of water to it in a boiling state. When cool, the ammonia should be added, and afterwards the solution should be filtered. It is advisable to make it up fresh as required. The addition of one ounce of alcohol has been recommended; the writer has failed to obtain any practical advantage by its employment. The substratum is applied as directed above.

The formula for the india-rubber solution (which should be poured over the cleaned plate like collodion) is—

India-rubber	1 grain
Chloroform (commercial)	1 ounce

Or,

India-rubber	1 grain
Benzole (rectified)	1 ounce

It will be remarked that all of these solutions are very dilute. If they were of greater strength it would be found that they were excessively liable to cause blisters in the collodion film.

The Collodion to be Employed.—The collodion to be recommended is such as will give by the wet process a brilliant and intense negative. The film should not be horny, whilst, on the other hand, it should not be of that character which admits of being easily torn. The writer has found that the addition of water to it causes a greater sensitiveness, doubtless owing to the porous state in which it is left. The following procedure may be adopted: —Take half the collodion to be used in dry plate work, and drop into it distilled water to such an amount that on coating a plate the film appears slightly reticulated. The remaining half should then be mixed with it, and, as far as the physical nature of the collodion is concerned, it will be found in good condition; the addition of a quarter to half a grain of nitro-glucose to each ounce will be found to secure density.

The Sensitizing Bath.—The bath should be such as will give a

good negative by the wet process. It should be of the strength of about 40 grains of silver nitrate to the ounce, unless highly bromized collodion be employed, in which case it may be of the strength of from 60 to 80 grains to the ounce.

Washing the Sensitive Film.—After sensitizing, it is necessary to eliminate the free silver nitrate from the film. The following method will be found efficient. Two flat dishes or dipping baths should be filled with distilled or purified water, and immediately after the plate is taken out of the bath it should be placed in one of them. It is of great consequence that the plate should be immersed in the water without stoppage. When using a flat dish a certain knack is required to effect this. The most successful method is to hold the plate nearly touching the surface of the water, and then to allow the plate to sink by its own weight. With a little practice, an even circular wave moves over the surface, and there will be a consequent freedom from markings due to this part of the preparation.

When the ether and alcohol have been absorbed by the first washing (which is known by an absence of all "greasy" appearance on the surface), the plate should be removed to the second dish or bath, and be allowed to remain at rest for four or five minutes.* It is then washed under the tap for a couple more, and finally rinsed with distilled water, when it will be ready for the preservative.

Applying the Preservative.—The preservative is usually applied by floating on the surface for about a minute. It is a good plan to allow the solution from one plate to flow back into the cup, and use this for a first flooding of the next plate, pouring it immediately away, and then applying fresh. By this means dilution from the water on the surface of the film is avoided. Some operators, in certain cases, apply the preservative by immersing the plate in a flat dish or dipping bath containing the solution. As a rule, this procedure is not to be recommended, as any contamination from one plate is liable to be carried on to another.

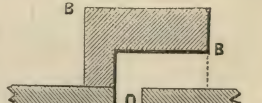
Drying the Plate.—After applying the preservative the plate is

* If the plates are required to be kept but a short time (say three or four weeks), a minute's washing under the tap is sufficient. The plate will be rather more sensitive than if the washing be prolonged. In the case where the preservative is washed off, the minute's preliminary washing suffices.

usually dried spontaneously,* or with the aid of heat, the temperature being maintained below 212°.

To the photographer who works with home-made dry plates a perfect drying-box is a *sine qua non*. It may be taken for granted that the larger the box the more even will be the drying of the plates, and consequently the better chance of perfection in the negative.

An ordinary cupboard may be converted. The shelves at the back edge should be pierced with holes close together, or an interval left between them and the back of the cupboard. About two and a-half inches from the back small tumblers† (such as described for developing cups) should be let into the shelf, the rim projecting about half an inch above the shelf itself. Small strips of glass should then be fastened round the cupboard, at such a height that when the corners of the plates which are to be dried rest in the tumblers, the opposite corners should rest against them. Ventilation should be secured by boring holes at the top and bottom, covering them with strips containing L-shaped holes. The accompanying diagram shows the form. A A is the top of the cupboard; B B, the strip of wood screwed on to cover the aperture O. The inside of the L-pieces and the side of O should be blackened, to prevent any reflection of light. If hot-water or hot-air pipes can be passed through the cupboard, it will aid the rapidity of drying. In this case, over the pipes, and at a distance of six inches from them, should be placed a sheet of perforated zinc. This will equalize the distribution of the heat to a great extent.



Another good plan for obtaining heat is to erect a cupboard (as described above) over a flat and closed galvanized iron bath. Fig. 1 (page 58) gives the elevation, and Fig. 2 the section. A is the bath, D the cupboard, which may conveniently be closed with a roller shutter,‡ B passing over *c c*, and is weighted by a bar of lead, so as to nearly balance the weight of the shutter when

* The plate should never be altered in position whilst drying, for if it be so a mark is sure to appear round the portion only partially desiccated.

† The small porcelain ink pots used for school desks are equally good.

‡ The shutter may be made of American leather, covered over with one quarter-inch strips of oak or well-seasoned pine. The shutter should fit into a groove which runs all round the front of the cupboard.

closed. A couple of Bunsen gas-burners, E E, heat the water in A; the steam generated is carried up the flue F, which also carries off the products of the combustion of the gas. Inside the cupboard an even temperature is thus maintained, and the plates dry satisfactorily. Ventilation may be secured as in the first-named

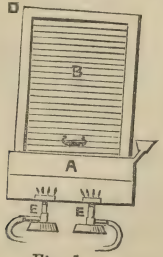


Fig. 1.

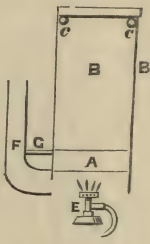


Fig. 2.

drying-box. If these drying-boxes be not available, any ordinary light-tight and large box may be temporarily converted into one. The plates should be ranged round the box with but one corner resting on the bottom of the box. Two or three thicknesses of blotting-paper should be placed beneath the supported corner to imbibe the drainings.

Development.—There are various methods of developing dry plates, but some are in most general use. When any special mode is to be adopted with any particular process, it will be indicated when describing the latter. The first point to be attended to before developing is to give an edging of india-rubber solution to the film, if no substratum have been applied to the plate. This is conveniently accomplished by using the appliance shown in the accompanying sketch. A piece of wood nearly square in section, and of about a quarter of an inch side, is cut in the shape shown. A narrow strip of swan-down calico is tied over the end, leaving the sides A and that opposite to it uncovered. The calico is charged with india-rubber solution from a bottle, and the notch applied to the edge of the plate. The projection supplies the solution to the edge of the film, and the part B prevents the wood slipping. This method secures the complete sealing of the film to the edges of the plate. For edging plates, about five grains of india-rubber should be dissolved in one ounce of benzole in the manner described at page 54.

The solvent of the india-rubber rapidly evaporates, and the plate will be ready for moistening. The operator should now consider whether water can be at once applied, or whether a preliminary application of spirits of wine would be advisable.

"Backing" the Plates.—Blurring, or halation, in a negative is a kind of "halo" effect, which is seen on a deep shadow when in close contiguity to an intensely high light; and some classes of dry plates are particularly liable to this defect. Thus, when dark trees are taken against a bright sky, the light of the latter appears to be partially continued on to the tops of the former. There are two causes to which this can be attributed: the first is the dispersion of light from the minute particles of the collodion and the sensitive salt; and the second is the reflections and re-reflections of the light from the surfaces of the plate. To minimize the effect due to the first it has been suggested to dye the film with a body such as aurine. This is not advisable, as from the nature of the remedy sensitiveness must be diminished to a great extent. A very transparent film, as is produced in certain albumen processes, or a very dense film, are both less liable to blurring from dispersion of light than if the film be of only medium density. If the reflections from the back surface of the plate could be converted into a non-actinic colour, their action will be *nil* on the film. This can be partially given by applying some non-actinic colour, such as gamboge, burnt sienna, &c., to the back of the plate. Should it be proposed to coat the back of the plate, the following will be found to answer well:—

Powdered burnt sienna	...	...	...	1 ounce
Gum	...	...	...	1 ,,
Glycerine ...	...	...	...	2 drachms
Water ...	...	...	...	10 ounces.

The solution is to be brushed in with a hog's-bristle brush. Ordinary printing paper, coated with a solution of gum-arabic to which a little glycerine has been added, stained with Judson's orange or crimson dye, and applied to the back of the plate, is perhaps the cleanest method of effecting the purpose.

Defects in Dry Plate Negatives.—Besides the defects that are common to both wet and dry plate processes, the following are to be noted as to be met with.

Blisters.—If blisters* make their appearance, it is probable, if the substratum be of albumen, that the solution is not sufficiently dilute. With some kinds of india-rubber blisters always appear.

Transparent markings may be caused by handling the plate with warm fingers before immersion in water previous to development. The corners of the plate alone should be touched.

Large opaque spots may be caused by allowing a warm finger to touch the plate during a preparation development.

A transparent edge will be caused by allowing the whole length of the edge of the plate to rest on blotting-paper when drying in the drying-box.

A lack of density is caused by the collodion being too thin, requiring more pyroxyline; by an insufficient quantity of iodide; by insufficient sensitizing in the bath; or by too weak an alkaline developer.

Lines may be caused by a stoppage in the wave of developing solution, by removing the plate in the drying-box previous to complete desiccation, or by an uneven flow of the preservative over the film.

Black spots on the film may be due to the india-rubber substratum, and to dust on the plate.

Transparent spots may be met with when photographing near the sea. They are probably due to the chloride of sodium which is held in suspension in the air. They rarely occur if the plate has been thoroughly dried finally by artificial heat a short time before exposure.

Pinholes may be caused by the solution of silver added to the developer dissolving out iodide from the film. If the preservative be not well filtered such defect may likewise occur.

If the preservative used for the dry plate contain any substance only slightly soluble in the former, but more readily in the latter, then the latter should be flowed over the plate and allowed thoroughly to permeate the film. A good washing under the tap afterwards is then necessary. If the preservative contain nothing soluble by alcohol, water should be applied in the first instance.

Whether spirits of wine or water be the agent used for softening the film, great care should be taken that there is no

* Warming the plate previous to coating with collodion is of service, preventing blisters.

stoppage in the flow, otherwise markings in the negative may become apparent. (A dipping bath or a flat dish is useful when water is to be applied.) The preservative must in all cases be eliminated from the film as far as possible before development commences.

THEORY OF ALKALINE DEVELOPMENT.*

At page 3 the general action of light on dry collodion films has been pointed out, and it has been stated that one of the uses of the preservative was to absorb the iodine and bromide liberated during exposure. The rationale of the method of developing the invisible image has also been given when it depends upon the oxidation of the developing agent and the consequent reduction of the free silver nitrate that may be present. With dry plates, and on some occasions with wet plates, there is another system pursued of calling forth the invisible image, and this mode of development is known as the "alkaline development." The silver compound to which it is usually applied is the bromide; chloride is, however, also amenable to it. It has been stated that silver iodide can also be attacked by this same development; but the writer has never been able to prove it, even when the strongest solutions have been applied. Taking silver bromide as a type of the compound attackable by this method, we have in the film of collodion, after exposure to light, silver sub-bromide. If pyrogallic acid be applied to this, it will be found that scarcely any developing action takes place, even after prolonged contact, but that if a drop of weak ammonia be added, a blackening of the exposed parts at once takes place.

It may be instructive to give an experimental proof of the action that is set up. If about twenty grains of silver bromide (prepared with an excess of alkaline or other bromide, or with an excess of silver nitrate, and thoroughly washed) be placed in a test tube and exposed to light, and on to it be poured a solution of pyrogallic acid, no darkening will be apparent excepting that due to the discolouration by the light. A drop of ammonia dropped into the tube and mixed with the solution by shaking, at once sets up a blackening of the solid bromide,

* As many of the processes to be recorded require modifications in development, it is considered better to give the formula with the preparation of the plates, merely stating here the theory of a peculiar mode of development adopted with certain classes of plates.

and a "browning" of the pyrogallic acid solution. Decanting off the liquid, and adding a little nitric acid to it, and then a solution of nitrate of silver, a precipitate instantly forms, which subsequent tests show is silver bromide. The precipitate, when thoroughly washed in the dark and treated with nitric acid, becomes of the ordinary buff colour of silver bromide, and on treating it with potassium cyanide it will be found that it is wholly soluble in that solvent of the haloids of silver. The part dissolved in nitric acid on treatment with hydrochloric acid shows the presence of silver. If a second portion of silver bromide be treated in a similar manner without exposure to light, the reaction observable will be *very slight*.

The following conclusions may therefore be drawn. The action of the alkaline pyrogallate is to combine with oxygen, and at the same time it evinces an avidity for bromine.* This latter it finds combined loosely with the silver sub-bromide, and the result is that when this compound exists we have silver left, which forms the image on the collodion film.

Silver Sub-Bromide	Pyrogallate of Ammonia	Oxygen	Silver	Compound of Alkaline Pyrogallate, Oxygen, and Bromine.
Ag_2Br	+ $\overline{NH_4\ 0\ Pyr}$	+ 0 =	2Ag	+ $\overline{NH_4\ 0\ Pyr\ Br\ 0}$

When there is only AgBr present (which perhaps might be more correctly written Ag_2Br_2) it will attack this compound, and eventually reduce it to the metallic state, causing what is known as fog. When the ammonia is in excess the same action in the AgBr will arise, even should there be Ag_2Br present. It is found in practice that a soluble bromide checks this tendency, but at the same time tends to destroy the latent image. It is to be presumed that this is due to a decomposition of this soluble bromide, the pyrogallic acid in the presence of ammonia absorbing the bromide, and the alkali absorbing oxygen.

It will be found that ammonia dissolves AgBr with difficulty; when pyrogallic acid, however, is employed with it, no trace of AgBr can be found in solution. It is to be inferred that the Br is absorbed by the ammonia-pyrogallate, and the Ag deposited as in wet-plate development. The fact that strong "alkaline developers" give the most intense images favours this idea.

* That pyrogallic acid *per se* has an avidity for Br may be shown by adding to a solution of it a drop of a nearly colourless solution of bromine water. The pyrogallic acid at once turns a brown colour.

Be the development by the acid or alkaline method, if the film be merely edged with india-rubber it frequently happens that the washing water gets more than the film itself, causing what appears to be one big blister. A small cut in the collodion near one corner will allow all the water to drain out, and in drying there will be no trace of any imperfection due to this cause. The manipulations of fixing, drying, and varnishing are similar to those given for the same operations in wet plates.

THE GUM-GALLIC PROCESS.

This process was first introduced by Mr. R. Manners Gordon, and in his hands, and those of many photographers, has proved of great value. The negatives are possessed of remarkable delicacy, and an appearance similar to wet plates.

To ordinary good collodion should be added a grain per ounce of bromide of cadmium, and the plates should be immersed for seven minutes in summer, and ten in winter, in order to convert the greater part of the bromide into the silver salt. They should be worked up and down in the bath till all greasiness disappears, and should then be left quiet till just before withdrawal.

After washing, the preservative is applied; it is made as follows:—

No. 1.	Gum-arabic	20 grains
	Sugar-candy	5 ,,
	Water	6 drachms
No. 2.	Gallic acid	3 grains
	Water	2 drachms

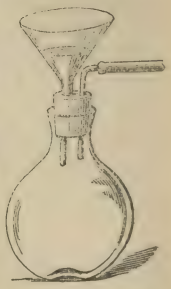
No. 2 is prepared with the aid of heat, and is then mixed with No. 1 in the proportions indicated.

The gum-arabic should be "picked;" that is, all yellowish lumps should be rejected, nothing but the white being used. Dealers supply the gum as picked if insisted upon.

The water used should be distilled, rain or purified. If it contain iron in appreciable quantity, it is fatal to success.

To filter this, great care should be taken to select a thin filtering paper which is free from iron. The presence of this impurity will be indicated by the solution turning an inky colour. It will be found to run through the paper better if the solution be kept warm.

A further aid to filtration will be given by the following contrivance, which, it may be noted, will serve to aid the filtration of most viscous bodies.



A cork or india-rubber stopper is pierced with two holes. Through one is passed a funnel containing a platinum foil support for the filter paper, and through the other a bent tube as shown in the sketch. By means of india-rubber tubing, this last can be connected with either an exhausting syringe, a Bunsen water-pump, or an aspirator of the usual form. The partial vacuum thus made causes the solution to pass with tolerable facility through the filter paper.

The preservative is applied by floating it on the surface for about one minute. The plate must then be allowed to drain, and be finally dried in the drying-box. If the plate, previous to exposure, appear dull, it should be dried by artificial heat before being placed in the dark slide.

Exposure.—Great latitude in exposure is admissible; it should rarely be less than four times, nor more than twenty times, that which would be required for wet plates under ordinary circumstances; though with the strong alkaline developer (for which see page 77) the exposure may be reduced to that necessary for a wet plate. Some recommend its employment if the plate be kept for a long period (say a month) between exposure and development. The ordinary developer, and one which yields splendid negatives from a well exposed and well prepared plate, is as follows:—

No. 1.	Gelatine (any kind will answer)	64 grains
	Glacial acetic acid	2 ounces
	Water	14 ,,
No. 2.	Ferrous sulphate	30 grains
	Water	1 ounce

Half the quantity of the water in No. 1 should be taken, and the gelatine allowed to soak in it till it be thoroughly swelled. The remaining half of the water should be added in a boiling condition, which will cause solution. The acetic acid should next be added, and the whole allowed to cool.

One part by measure of No. 1 should be mixed with three parts of No. 2, and then filtered. It is inexpedient to mix

more than is necessary for one or two days' use, as the iron undergoes oxidation. No. 1 will keep indefinitely, whilst No. 2 should be made as required.

To every drachm of developer used, one minim of a solution of silver nitrate (30 grains to the ounce) should be added just previous to the application to the plate.

To develop the image, the backing (if any) must first be entirely removed with a damp rag, or peeled off in the case of paper backing. The plate should then be immersed in a dish of water of not less than 65° Fahr. for two or three minutes, to soften the gum, and be finally rinsed under the tap. The developer should be now flowed over, and, if properly exposed, the image will begin to appear almost immediately. As it appears, more silver solution must be added, by two or three drops at a time, till the whole of the detail is visible. The film must next be well washed, and intensity gained by the ordinary pyrogallic acid intensifier and silver solution. The negative should have all the characteristics of a wet plate if properly manipulated. Should it be inferred that the plate is over-exposed, more of No. 1 may be added to the developer. It is important that the silver solution be added to the developer previous to flowing over the plate. If the latter be applied alone, and then silver be added, the resulting negative is liable to be granular in appearance.

THE COFFEE PROCESS.

There have been various modifications of this process; the best, as far as experience has taught, is that of M. de Constant. It is thoroughly reliable, and the plates prepared by this method keep well, and give soft negatives.

The collodion to be recommended for this process, according to M. de Constant, is ordinary collodion, with the addition of two grains of cadmium bromide to the ounce. If collodion be home-made, the pyroxyline should be manufactured at a high temperature in the acids, and may be known in commerce by its yellow appearance, and by being found to separate in hard rather than in fibrous particles.

The plate is coated and the film sensitized, and washed as before described, in the ordinary way.

The preservative is formed as follows:—

No. 1.—Boiling distilled water	...	5½ ounces
(Mocha) coffee	...	½ ounce
White sugar	...	90 grains
No. 2.—Distilled water	...	5½ ounces
Gum-arabic	...	90 grains
Sugar-candy	...	20 ,,

No. 1 is allowed to cool in a well-corked bottle, and both solutions should then be filtered and mixed. It is found convenient to pound the gum-arabic and sugar-candy in No. 2 before adding the distilled water.

The film may be coated with the preservative in the ordinary manner, two applications of a minute's duration being necessary. It is *better* to use a flat dish to *immerse* the plate in for two minutes, as evenness of coating is thereby insured. The plate should be then placed on end, upon folds of blotting-paper, to drain, previous to placing it in the drying-box.

The usual precautions for drying are to be observed in this as in the last process. When thoroughly dry the surface of the film assumes great brilliancy, and exhibits neither stain nor fog by transmitted light. If a cloudy aspect be on portions of the film, a heated flat iron passed over it, an inch from the surface, will restore the brilliancy, and the plate will be fit for use.

M. de Constant states that the exposure required for these plates is three times the length required for wet plates, under precisely similar circumstances. It is better to give six times the exposure, as the development is easily controlled in a slightly over-exposed picture. In bright sunshine, it is stated that comparatively longer exposure is requisite than in cloudy weather.

The plates are very transparent, and there is a consequent tendency to blurring of the image. In such a case "backing" must be given.

Before development the plate should be covered with, or else immersed in, rain or good ordinary water for three or four minutes, and kept in motion. The water should then be drained off. For an 8½ by 6½ plate the following must be flooded over the plate:—

*Saturated solution of carbonate of ammonia...	8 drops
Water	4 drachms

* One drop of concentrated liquor ammonia may be substituted.

This is worked over the plate till the image begins to appear, or till there is no further action caused by it. Return this from the plate into the developing-cup, in which shall have been dropped from one to two drops of the following solution:—

Pyrogallic acid...	60 grains
Alcohol...	1 ounce

The ammoniacal water, with this solution added, should be now swept over the plate in a manner similar to that employed in developing a wet plate, as its action is extremely rapid. The image will now appear fully by reflected light, but be barely visible by transmitted light. The action of this solution must be continued till every possible detail in the shadows is brought out. The image may now be intensified by the ordinary pyrogallic intensifier (page 22); but by this method it will always appear transparent. To prevent this, M. de Constant uses the following before the final pyrogallic intensification:—

Ammonio-sulphate of iron ...	45 grains
Copper sulphate	45 ,,
Citric acid	45 ,,
Water	3½ ounces.

It will remain in good condition for a considerable length of time.

Two or three drops of a 20-grain solution of silver nitrate may be added to this after the first application. On the second application the negative becomes of a colour resembling that of a wet plate. The ordinary intensifier should be used after this. If the negative tend to become solarized (*i.e.*, to turn a reddish colour in the shadows), it should be fixed at once, and intensification take place afterwards.

The methods of development given for England's process and for the Tannin process also answer satisfactorily.

Either sodium hyposulphite, or a weak solution of potassium cyanide, may be used for fixing the image. If the latter agent be used, a few drops of acetic acid should be dropped into it before application; this prevents blistering.

THE COLLODIO-ALBUMEN PROCESS.

The collodion should be very old and powdery. The dregs of different samples may all be thrown together, and though almost entirely insensitive for the wet process, it will be found to be no

drawback for this; even collodion that sets opalescent is suitable. Mr. Mudd, whose exquisite landscapes are produced by this method, advises that it should contain no bromide; other workers do not insist on this condition.

The ordinary negative bath is used. The plate being sensitized as usual, is washed thoroughly till *all* the free silver nitrate is removed.* The plate is then flowed over with the following:—

Albumen	8 ounces
Ammonia	2 drachms
Potassium iodide	50 grains
Potassium bromide	10 grains
Water	$2\frac{1}{2}$ ounces.

This operation should be repeated twice, taking fresh solution every time. (The salts are first dissolved in the water, next the ammonia added, and then the solution mixed with the albumen. The whole is then beaten to a froth, and allowed to settle, and the clear liquid decanted or syphoned off for use. The eggs should be fresh, if possible. Before use, the solution should be filtered through a piece of sponge plugged into a funnel.)

The plate is next slightly drained, and set up to dry. At this stage it is quite insensitive to light if no bromide be present in the collodion, and will keep indefinitely. Before use, resensitizing must take place. A bath must be prepared made as follows:—

Silver nitrate	30 grains
Glacial acetic acid	$\frac{1}{2}$ drachm
Water	1 ounce

Into this the dried plate must be dipped, and be allowed to remain in it for at least one minute—ten will not hurt it. After withdrawal it must be thoroughly washed, and then be set up to drain. When the excess of water has been absorbed, it is placed in the drying-box, and allowed to dry spontaneously.

Plates thus rendered sensitive will keep for a week in hot

* It may be immersed in a five-grain solution of potassium iodide to secure this result.

weather, but longer in cold.* The newer the plates the better will be the result. They will keep after exposure, which is of great advantage to the tourist.

The required exposure is long—in fact, it is almost impossible to over-expose; at least ten times the exposure of an ordinary sensitive wet plate should be given, whilst twenty times would be better.

To develop, wash the plates thoroughly, and flow over them—

Pyrogallic acid	...	...	...	3 grains
Water ...	...	...	...	1 ounce

After a few minutes the outline of the sky will appear by reflected, though nothing will be visible by transmitted, light. *Nearly* all the detail should be brought out, and but little to be done by the subsequent intensification. A considerable quantity of unaltered iodide should be visible in the image. If over-exposure be suspected, the image may be brought out by the developer to be described (page 73), whilst if under-exposure be probable, the pyrogallic acid in the above may be increased to six grains, or even more. To bring up the image to printing density, the following is applied with three or four drops to each ounce of a solution of silver nitrate (30 grains to the ounce of water):—

Pyrogallic acid	...	...	...	2 grains
Citric acid ...	...	...	...	½ grain
Water ...	...	...	...	1 ounce

During the operation a slight deposit may take place on the surface of the film. This can be removed by carefully wiping it with a tuft of cotton wool. When of proper strength, the image should be fixed with sodium hyposulphite (see page 26).

An under-exposed picture may be forced up by using the plain pyrogallic solution warm, or, as before mentioned, by increasing its strength, or also by alkaline development as for the albumen-beer process (page 73).

The sky in the pictures produced by this process is rarely sufficiently opaque. Painting out must be adopted, an operation tedious, and often unsatisfactory.

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* If a saturated solution of gallic acid be applied after the final washing, the plates will keep sensitive for months.

ENGLAND'S COLLODIO-ALBUMEN PROCESS.

A very useful modification of the foregoing has been introduced by Mr. England. The plate is cleaned, sensitized, and thoroughly washed. It is then flowed over with diluted albumen, the white of one egg to one ounce of water in cold weather, and two ounces of water in hot weather. These are well shaken up in a bottle till the albumen is thoroughly incorporated with the water, and the solution is filtered through sponge. The plate is next rinsed to free it from superfluous albumen, and a silver solution (made similarly to the bath, acidified with acetic acid in the last process) is flowed over the film without any stoppage, and allowed to remain on it for a minute. It is then thoroughly washed, and allowed to dry spontaneously. The exposure is about the same as for a gum-gallic plate, and the development is conducted as for the collodio-albumen process.

HOT WATER PROCESS

The last process may be varied by immersing the plate, immediately after it is floated with the preservative, in boiling water, to coagulate the albumen, and flowing over it a saturated solution of gallic in water, and setting up to dry. The development may be carried on as above, or by the alkaline method.

TANNIN PROCESS.

With this process bromo-iodized collodion is to be used. The plates require a substratum or an edging. After well sensitizing, they are thoroughly washed in distilled water, rinsed under the tap, and finally with distilled water. The preservative—

Tannin (pure)	... 10 to 15 grains
Distilled water	... 1 ounce

is then flowed over them. (The addition of gum ten grains, and sugar five grains, is recommended by some, but the advantage is not very apparent.)

The exposure required is about one and a half times that of a gum-gallic plate.

To develop a plate, it is first flooded with spirits of wine and water, and then washed.

The developing solutions are—

No. 1.—Pyrogallic acid	... ...	144 grains
Alcohol	... ...	2 ounces
No. 2.—Silver nitrate	... ...	60 grains
Citric acid	... ...	60 ,,
Distilled water	... ...	3 ounces
Take of No. 1	... ...	16 drops
No. 2	... ...	8 ,,
Water	... ...	1 ounce

Flow this over the plate till the detail is well out, when five or six drops more of No. 2 must be added to give intensity. These plates are sometimes most satisfactory, at other times they are full of pinholes and stains. A good batch will keep well for two or three months.

This process may also be carried out by using a collodion containing nothing but bromide; the formula for which is—

Ether	... ...	½ ounce
Alcohol	... ...	½ ,,
Pyroxyline	... ...	6 grains
Cadmium bromide	... ...	8 ,,

The plate coated with this collodion is immersed in a bath of the following—

Silver nitrate	... ...	80 grains
Water	... ...	1 ounce

No iodide need be added. The remaining operations are similar to those described above. Alkaline development, described at page 77, may be employed.

With a strong alkaline developer the exposure is shortened to that of a wet plate.

ALBUMEN BEER PROCESS.

The following process was introduced by the writer for solar photography, and was employed by the English Transit of Venus Expedition. It is, however, equally adapted for landscape work, and is very certain in its results. The collodion employed can be

that described at page 55, though for more rapid work the following is better:—

Alcohol ·825...	4½ to 3 drachms
Ether	3½ to 5 ,,
Pyroxyline	... 7 grains
Ammonium iodide	... 2 ,,
Cadmium bromide	... 5 ,,

The relative proportions of ether and alcohol are adjusted according to the temperature in which the plates have to be prepared.

With the ordinary samples of collodion the usual 40-grain silver nitrate bath can be used, but with the collodion made as above it is advisable to use a bath made up to 60 grains, preparing it as given at page 15. In both cases rapidity is increased by the addition of ten grains of uranium nitrate. It has also been found advantageous to dip the plates in the weaker bath, at first allowing them to remain in it for a couple of minutes, and then to transfer them to the stronger for ten minutes more. This mode of procedure gives very sensitive and opaque films, the greater part of the actinic rays being thus utilized. The sensitiveness, however, greatly depends upon the porosity of the film, and every effort should be made to attain the maximum of this quality without injuring its texture. The addition of the largest practicable amount of water to the collodion tends to give this quality. After sensitizing, the plate is slightly washed, and then the first preservative applied, which is—

Albumen	1 fluid ounce*
Water	1 ounce
Ammonia	1 drachm

This is beaten up into froth (or is mixed by pounding it in a mortar with silica), and when settled the clear liquid is decanted off. This solution is mixed with equal quantities of any ordinary beer or stout immediately before use,† and is floated over the plate. (When bottled beer is used, it is advisable to drive off all the carbonic acid by a gentle heat.) The excess is drained off, and the film thoroughly washed under the tap for a

* Dried albumen 25 grains may be substituted for the fluid ounce.

† This precaution is necessary, otherwise the tannin of the beer is precipitated by the albumen.

couple of minutes, and is finally covered with a solution of plain beer, to every ounce of which two grains of pyrogallic acid have been added.

The plate is then dried in the ordinary manner.

The exposure with well prepared dense plates is at least as short as that necessary for wet plates, but great latitude is admissible. With twenty times the minimum exposure, a good negative can be obtained.

The development need not be effected for a month after exposure. The following solutions are required :—

No. 1.—Pyrogallic acid	12	grains
Water	1	ounce
No. 2.—Liquor ammonia (·880)	1	part
Water	4	parts
No. 3.—Citric acid	60	grains
Acetic acid	30	minims
Water	1	ounce
No. 4.—Silver nitrate	20	grains
Water	1	ounce

The washing water before development should be of a temperature no less than 60° Fah. When washed as directed (page 56), the following developer is employed :—

To each half ounce of No. 1 are added three drops of No. 2, and after well mixing with a stirring-rod the solution is flowed over the plate.

Almost immediately the image begins to appear, and after a few seconds' interval the detail can be seen by reflected light to gradually develop. Another two drops of No. 2 are again added to the solution, which is once more flowed over the plate. Six drops of No. 3 are next dropped into the developing cup, and the solution from the plate poured on to it. Again the plate is rinsed, this time by the acid solution, and intensification is given by the use of it with a few drops of No. 4. It is advisable not to allow too much detail to come out with the alkaline solution, but to allow a portion of it to be brought out by the subsequent treatment with the pyrogallic acid and silver. The alkaline developer reduces the bromide salt, and leaves the iodide to be attacked by the silver solution. It will be remarked that no restrainer such as bromide is employed ; the albumen dissolved by the ammonia plays the part of a retarder, but not as a destroyer, of the latent image.

When the image appears sufficiently dense, it is fixed by either sodium hyposulphite or by potassium cyanide.

A TEA PROCESS.

Of all dry processes, the tea process is the most charming, when exposure can be given to the plates within two or three days of preparation. They can be developed by the gum-gallic, iron, or alkaline developer. They possess a beauty not obtainable by most processes.

The plate is coated with a bromo-iodized collodion, sensitized as usual, a preliminary coating or edging having been given to it. After thorough washing it is *immersed* in an infusion of tea. This latter is prepared by pouring about ten ounces of boiling water on half an ounce of good black tea. After standing one or two hours it is filtered, and is ready for use. It will not bear the addition of either gum or sugar. The plates require about three times the exposure of wet plates, and should be developed within twenty-four hours afterwards.

EMULSION PROCESSES.

The emulsion processes which are now to be described differ from all others previously described, in that the sensitive salts are formed in the collodion itself by direct application of a solution of silver nitrate, and not by immersing a film in the solution. The principal sensitive salt is invariably the bromide, though it is frequently recommended to use with it chloride and iodide. An emulsion is formed readily with the chloride and bromide, but with iodide greater difficulty is experienced.

It has been found practically that the formation of a small quantity of the chloride with the bromide emulsion prevents the plates fogging when an excess of silver nitrate is added to the collodion. On the other hand, it is not required if a slight excess of soluble bromide remain unconverted. No doubt greater sensitiveness in an emulsion is attained by forming an emulsion with the silver nitrate in excess, but it is not so stable a compound as if it be in slight defect. When the former is the case, the emulsion becomes thin and limpid unless other precautions be taken. With the latter it remains fit for use for a

longer period. Washed emulsion, which will presently be described, will keep indefinitely, and remain at a standard sensitiveness.

The pyroxyline for the collodion to be preferred in these processes is that which is prepared at a high temperature, and with proportions of acids differing to that already given at page 6. The following formula is that published by Mr. L. Warnerke, and due to Col. Stuart Wortley. It has been found by the writer to yield a compound which has all the necessary properties for emulsion—viz., porosity with its consequent sensitiveness, and a capacity for taking intensity at a single application of the alkaline development. One hundred grains of the finest cotton wool are put into a porcelain jar, and thirty grains of gelatine dissolved in the smallest amount of water are added. By pressing it with a wooden stick all the cotton will be uniformly impregnated. It is subsequently very thoroughly dried before the fire.

Nitric acid (sp. gr. 1·450)...	4 oz., or	sp. gr. 1·42 ...	35½ dr.
Water	12½ dr.	ditto ...	9 dr.
Sulphuric acid (sp. gr. 1·840)	6 oz.	ditto ...	6 oz.

are mixed in the order named, and, by means of a water bath, the temperature is kept up to 158° Fah. The dried gelatinized cotton, weighing about 130 grains, is immersed in the mixed acids for about twenty minutes. Here it should be observed that with some cotton it is impossible to preserve this temperature. The slightest tendency to dissolve at once raises the temperature rapidly, and the cotton speedily disappears. With such a sample of cotton the temperature must be lessened to such a degree that this result does not obtain. The pyroxyline is now washed and dried as in the preparation of the other pyroxyline. The addition of the gelatine to the cotton causes the formation of nitro-glucose when in the acids, and most of this is lost in washing. The writer has found that by dissolving one grain of this substance with every five of the pyroxyline an extraordinary degree of density can be given.

CANON BEECHEY'S PROCESS.

The first process to be described will be Canon Beechey's, as it is very simple and most efficient. The following is the *modus operandi*:—

Take cadmium bromide (anhydrous) ... 400 grains
Alcohol (·805) ... ... 10 ounces

and allow the mixture to stand. Decant carefully, and add eighty minims of strong hydrochloric acid.

Take of the above solution	...	½ ounce
Absolute ether (·720)	... ...	9 drachms
Pyroxyline (as above)	...	10 to 12 grains

To sensitize this, dissolve forty grains of silver nitrate in one ounce of alcohol (·820 sp. gr.) The best method to effect this is to pound up the silver nitrate in an agate mortar, and take only a quarter of the alcohol and boil it in a test tube containing the silver salt. The alcohol will become slightly brown (due, probably, to the formation of a fulminate of silver), and should be decanted off into the bottle containing the collodion. The remaining silver should be dissolved up in a similar manner, the ounce of alcohol being just sufficient to effect solution. Between each addition of the silver nitrate the collodion should be well shaken. When the final addition is made the emulsion should be very smooth and rather thick. When poured upon a strip of glass plate it will appear transparent by transmitted light, but after keeping twenty-four hours (occasionally shaking the bottle containing it in the interval) it ought to be very opaque and creamy.

The plate having been coated with a substratum or edged, the collodion (which should have been shaken about half an hour* before it is to be used) is poured on it in the ordinary manner, and, when set, immersed in a dish of distilled or rain water. When all greasiness has disappeared it is flooded with any of the preservatives already mentioned. Canon Beechey recommends the plate to be immersed in a dish containing beer to which one grain per ounce of pyrogallic acid has been added. The drying is conducted in the usual manner. The exposure may be taken to be about the same as that necessary to be given to a gum-gallic film. Between exposure and development the plates will keep fairly for a week, but after that seem to lose detail, and appear under-exposed. Strong alkaline development was introduced by Col. Stuart Wortley, and has placed a wonderful power in the hands of the photographer. It is recommended for this, and applied to various other processes, and subsequent reference will be made to it.

1.	Pyrogallic acid ...	... ...	96 grains
	Methylated alcohol	... ...	1 ounce

* Canon Beechey recommends the bottle to be shaken immediately before use, and the emulsion filtered.

No. 2.—Potassium bromide	...	...	12 grains
Water distilled	...	...	1 ounce
No. 3.—Ammonium carbonate	...	...	80 grains
Hot distilled water	...	...	1 ounce

Or,

Liquor ammonia	...	...	25 minims
Water	...	...	1 ounce

To develop the plate, take of—

No. 1	...	...	...	½ drachm
No. 2	...	...	...	1 drachm
	(½ drachm in cold weather.)			
No. 3	...	...	...	2 drachms

These are the proportions for a plate 7½ by 4¼. Should the preservative on the plate be soluble in alcohol, then that solvent should first be applied to the plate (edged round with india-rubber if necessary), and then be washed till all the alcohol has been removed. It is very convenient to develop these plates on a levelling stand, in which case the india-rubber edging is a great help to keeping the solution on the plate. The above solutions should be mixed immediately before use, and after well stirring with a glass rod be flowed over the plate. When the detail begins to appear the bulk of the solution should be poured back into the developing glass, and the appearance of the image watched. If the detail appears slowly and regularly, the developer should be again flowed on the plate, and the image be allowed to gain full intensity. If, however, it appear very slowly, and with apparent difficulty, another drachm of No. 3 should be added to the solution in the glass, and again be applied to the film. If the detail flash out at once, the action must be instantly checked by water, and another half drachm of No. 2 be added to the developing solution, which should be again applied.

Should sufficient intensity not be gained by this alkaline method, the ordinary intensifier (page 22) should be applied afterwards. It is not always easy to secure sufficient density with emulsion plates, even by the application of silver and pyrogallic acid. In this case, after fixing, the image may be converted into iodide of silver by the iodine solution (page 22), be washed, flooded with a weak solution of silver, be exposed momentarily to light, and be then intensified by iron or pyrogallic acid. The plates are fixed by potassium cyanide, or sodium hyposulphite (page 26)

Another mode of developing these plates is one lately proposed by Mr. J. T. Taylor, who employs a colloidal restrainer introduced by Mr. Carey Lea. This last is prepared by taking one ounce of French glue, and softening in one and a-half ounce of water to which one drachm of sulphuric acid is added. The water is then boiled, to dissolve the gelatinous body, and, after the addition of half an ounce more of distilled water, the boiling is continued a couple of hours. Eighty grains of granulated zinc are next added, and the boiling again continued for one and a-half hour more. The solution is now allowed to settle, and the clear fluid is decanted off. To every three ounces of a fifteen-grain solution of iron one minim of this solution is added. The development must be carried out precisely in a similar manner to that described for the gum-gallic process, substituting the above iron solution for that given. It should be noted that a film to which an albumen preservative has been applied is very difficult to develop by any iron salt, and the writer never attempts this mode of development on plates so prepared.

URANIUM DRY PLATE PROCESS.

The later modifications of this process are not published; but the original form was so satisfactory in the hands of many that it is given here.

Col. Stuart Wortley experimented largely and fully in the emulsion processes, and found that the addition of the uranium nitrate to an emulsion added to the sensitiveness of the plates, and rendered the tendency of the silver bromide, when prepared with an excess of nitrate of silver, to deposit, to be much lessened. The uranium likewise he found to restrain "fog" or veiling of the image.

It should be here stated than an excess of nitrate of silver in this emulsion renders the dry plates very rapid, nearly approaching that of wet. The following is taken from a paper read by Col. Wortley before the Dry Plate Club in April, 1872:—

The plain collodion is made with pyroxyline prepared at a high temperature.

The emulsion is made as follows:—

Plain collodion	... 1 ounce
Anhydrous bromide of cadmium	... 7 grains
Nitrate of uranium	... 30 ,,
Nitrate of silver	... 13 ,,

The nitrate of uranium should be pure, and *very slightly* acidified with nitric acid. The uranium salt and bromide of cadmium should be dissolved in the collodion, and the nitrate of silver added as directed before. The plate should have a substratum, and be coated as usual; when set, it is washed in distilled water till all greasiness disappears, when any of the usual preservatives may be flowed over it. Preservatives containing sufficient gum to give a protection to the film tend to cause blisters on development. Col. Wortley recommends the following as giving freedom from this annoyance:—

The following stock solutions are prepared:—

No. 1.—Salicine, enough to make a saturated solution in distilled water.

No. 2.—Tannin	60	grains
Distilled water	1	ounce
No. 3.—Gallic acid	48	grains
Alcohol	1	ounce.

To make the preservative, take of—

No. 1	2	ounces
No. 2	1	ounce
No. 3	½	,,
Sugar	40	grains
Water	7	ounces.

This preservative may be used over and over again with occasional filtering. The plates are best immersed in it.

Aurine must be introduced into the plain collodion, or else a backing must be given, to prevent blurring.

For the development of these plates, the following solutions must be prepared:—

1.—Carbonate of ammonia*	64	grains
Water	1	ounce
2.—Bromide of potassium	4	grains
Water	1	ounce
3.—Pyrogallic acid	96	grains
Alcohol	1	ounce

With any preservative which is soluble in alcohol the plates should be flowed over with spirits of wine diluted with twenty to thirty per cent. of water (which may used over and over

* Liquor ammonia twenty drops, water one ounce, may be substituted if necessary.

again). When well soaked into the film, and the aurine removed, a thorough washing must be given.* Then mix the developer in the following proportions :—

No. 1	...	...	...	60 minims
No. 2	...	...	...	60 ,,
No. 3	...	...	...	15 ,,
Water (distilled)	...	...	...	2 drachms
Spirits of wine	...	...	...	½ drachm

The plate is covered with this in the usual manner, and worked about. As the detail appears, more ammonia (No. 1) is added with half the quantity of bromide (No. 2).

The following paragraphs are from Colonel Wortley's directions for development, and are worthy of attention :—

"According to the way in which the plate comes out, you will see whether the exposure and development have been right. If the plate flashes out at once on the application of the developer, it is over-exposed, and more bromide should be added at once, to control the development. If, on the contrary, the negative remains for thirty or forty seconds without the picture appearing, it will be a sign of under-exposure, and from ten to twenty drops of No. 1 may be added to the developer.

"It may be that some pictures taken in a weak light may require much forcing: if so, remember to add the same proportion of No. 2 with No. 1. If the plate is very clear, and devoid of detail, it may be permissible to add a few drops of No. 1 without any No. 2. Bear this rule ever in mind. If you wish the plates to work more quickly, reduce the bromide in the developer; if there is any tendency to fog, increase the bromide or decrease the exposure.

"On any dark spot in the picture, where there is a dark shadow, pour the solution constantly, which will soon bring out the detail. It is frequently very useful to pour the developer off the film, and leave the negative on the developing-stand, with no solution on it, for a minute or two at a time, as that assists to bring both detail and density. In pouring off the developer, rock the plate, so that the former does not run in lines. I may here note, that when a plate has had too short an exposure, or the subject badly lit, it is well, if the first lot of developer appears to have exhausted its action, to make up a

* If the plates have "backing," it should be removed previous to the washing.

second quantity by adding to the four drachms of water ten drops of No. 3, thirty drops of No. 1, and twenty drops of No. 2; continuing to add No. 1 freely with the same proportion of No 2 till the negative is finished."

It is probable that this development will give insufficient density, unless the plates be prepared with an excess of bromide, or with some organic salt of silver (as in the case with certain new ammonia plates). The *ordinary* pyrogallic acid intensifier may be employed with a thirty-grain solution of silver.

Either sodium hyposulphite or potassium cyanide may be used as fixing agent. Intensification may be carried on after fixing if required. This, perhaps, is a safer plan than doing so before.

WASHED EMULSION PROCESS.

When to a soluble bromide in collodion silver nitrate has been added, and an emulsion of silver bromide formed, there remains as the result of the reaction nitrate held in solution, or perhaps in minute suspension. If the emulsified collodion were applied to a plate, and allowed to dry in this state, there would be a crystallization of these nitrates, and unless they were removed the film would be in an unsatisfactory state for removing the image. Washing the film of course effects this; but recently it has been proposed by Mr. King to remove the nitrates by dialysis, and also by Mr. Bolton, one of the originators of the collodio-bromide process, by washing the emulsion *previous* to coating the plate. This allows the plate to be prepared by the simple application of the collodion. The method of dialysis is very neat and scientific in principle, but it is not likely to be so much employed as Mr. Bolton's method; the latter will therefore be given in detail.

The pyroxyline is prepared at high temperatures, the salts dissolved in the collodion, and the silver nitrate is added in the manner to be immediately described. The collodion containing the emulsion is next poured out into a flat dish, to a depth not exceeding a quarter of an inch, and the ether and alcohol allowed to evaporate till the collodion sets, but *not till it dries*. This is best attained by continually stirring up the mixture with a glass rod, and the evaporation is materially aided by placing the dish over a water bath. When set, any preservative with which it is desired to impregnate the

emulsion is poured on it, and the gelatinous mass ploughed up with the rod into flakes. The contents of the dish is now bodily transferred to a jar, and left (with an occasional stir) for fifteen to twenty minutes. The jelly is next drained and washed for two or three hours, and finally dried spontaneously, or very gently over the water bath.

To re-emulsify, the dried collodion pellicle is covered with the proper amount of ether and alcohol, and shaken at intervals till it is dissolved in them. It should be noted that the absolute dissolution of the dried pyroxyline sometimes will take a couple of days or more to accomplish, though twelve hours is sufficient to give a smooth mechanical mixture. By transmitted light it should be invariably of a *red orange colour*.

The plate can now be simply coated with the emulsion, and when dried is ready for use. The first solvents of the collodion may be methylated, and not so concentrated as those employed finally. There are almost as many modifications of this process as there are preservatives, but the above will indicate the method of procedure in all.

CAREY LEA'S PROCESS.

As an example of this method, it has been thought that Mr. Carey Lea's might be taken as a representative one, that distinguished photographic chemist having been able to emulsify silver iodide together with the bromide and the chloride.

The collodion is made as follows :—

Ether ·730...	½ ounce
Alcohol ·805	¼ ,,
Pyroxyline...	8 grains
Cadmium bromide (crystallized)	6½ ,,
Ammonium bromide	2 ,,
Ammonium iodide	1⅓ ,,
*Copper chloride	1½ ,,
Aqua regia	2 drops

The emulsion is formed by adding to the above 20 to 25 grains of silver nitrate dissolved in half an ounce of alcohol. The additions should be made little by little, shaking between each. After the emulsion has been allowed to ripen for twenty-four to thirty-six hours, care being taken to shake the bottle containing it

* Cobalt chloride has been substituted for this salt, and is said to give better results. Hydrochloric acid (2 drops) may be substituted for it, and also for the aqua regia.

thoroughly at intervals, it will be found to be p erfectly smooth and creamy. It is then poured into the dish, an d allowed to set as before described. The following preservat ive is the one recommended by Mr. Carey Lea :—

Thick solution gum-arabic with a little sugar	1 ounce
Prepared albumen	1 ,,
Gallic acid (in 1 ounce of alcohol) ...	... 60 grains
Tannin (in 1 ounce of water)... ...	... 60 ,,
Water	... 12 ounces

The albumen is prepared by the addition of an equal bulk of water to the white of an egg, clarifying with twelve drops of acetic acid to each ounce. The solution after filtering through sponge is that referred to in the above formula.

The ordinary beer preservative, as given for Canon Beechey's process (page 76), is effective, also the albumen beer as described at page 72.*

Exposure.—The exposure is about double that required for a wet plate.

The development recommended by Carey Lea is as follows :—

1.—Pyrogallic acid	... 4 grains
Water	... 1 ounce
2.—Potassium bromide	... 15 grains
Water	... 1 ounce
3.—Ammonium carbonate	... 80 grains
Water	... 1 ounce

To 3 ounces of water add 1 ounce of No. 1 and 15 minims of Nos. 2 and 3. The detail will gradually develop. When perfectly apparent, the same quantities of Nos. 2 and 3 again are added, and so on till sufficient density is gained.

The development may also be carried out by any of the methods indicated for the particular preservatives.

A very useful emulsion process is that made as above, using the following formulæ :—

Methylated ether	... 1 ounce
Methylated alcohol...	... ½ ,,
Pyroxyline, high temperature ...	6 to 8 grains
Zinc bromide	... 10 ,,
Aqua regia	... 1 drop

* When the larger proportion of silver nitrate is employed, Mr. Carey Lea recommends the addition of one-tenth the bulk of the preservative of dinary acetic acid.

To this is added (after solution in half-ounce alcohol ·830) fourteen grains of silver nitrate, shaking well as the addition is made. The emulsion is then treated as above, and re-emulsified in equal parts of ether and alcohol ·830.

There are several firms which supply prepared collodio-bromide and collodion dry plates.

The Liverpool Dry Plate Company, St. John's Hill, Clapham Junction, supply collodio-bromide plates, and also an emulsion ready for use. The latter is made by the washed collodio-bromide process, and requires no application either of water or preservatives.

Messrs. Chambers and Co., 251, Goswell Road, London, E.C., supply the latest form of the uranium dry plates; and Messrs. Rouch likewise supply collodio-bromide plates which give very satisfactory results. Collodio-albumen plates are obtainable from J. Pollitt and Co., Barlow Court, Market Street, Manchester. With all of these full directions for exposure and development are sent out. The photographer will often find the possibility of the purchase of any of these dry plates a boon when too busy to prepare his own.

Mr. L. Warnerke has formed a substitute for glass which promises to be of great use for photography in the field. He coats ordinary stiff paper with thin solutions of india-rubber and collodion (see the heliotype process for the kind of collodion employed) alternately till a thickness of the substratum is about that of a thin sheet of paper. This he coats with washed emulsion in collodion, and exposes in the camera. To develop his negatives he turns up the edges of the paper to form a little dish, and applies the solution in the ordinary manner. When fixed, washed, and dried, the india-rubber collodion bearing the image is pulled off the paper, and the negative picture is on a flexible support which can be printed from either side. The picture may also be developed on a glass plate by stripping the paper off before that operation.

THE GELATINO-BROMIDE PROCESS.

In the gelatino-bromide process the employment of collodion is obviated, gelatine being the vehicle in which the bromide emulsion is held in suspension. There seems to be a certain advantage in using gelatine, as the sensitive salts are in a much minuter rate of subdivision than in collodion. It may be taken as an

axiom that the smaller the particles the greater effect will light have on them, and the greater the facility for development. The following is Mr. Kennett's mode of preparing these plates, and as in his hands the negatives are everything that can be desired, it has been thought that it would be preferable to give his method, rather than any other of the various modifications published. One pound of Nelson's gelatine is soaked in 100 ounces of distilled water, and after it is completely swelled, the jar containing it is heated and solution effected. While still hot, $8\frac{1}{4}$ ounces of potassium bromide are added to and thoroughly incorporated. Next $11\frac{1}{4}$ ounces of silver are dissolved in the least possible quantity of water, and poured into the jar little by little with constant stirring. In the state in which the emulsion is at this time it is insensitive, owing to there being an excess of potassium bromide; but in all subsequent operations non-actinic light must be employed.

The emulsion is poured out into a dish, as described at page 81, and allowed to set, when it is cut into strips and washed in a large number of changes of water (say for six hours). When thoroughly washed free of all soluble salts, the gelatine may be dried by evaporating out the water by heat till it is of the consistency of paste, when it is allowed to set, and finally dried. In this state it will keep any length of time, and Mr. Kennett has obtained a patent for this part of the process. Take at the rate of forty grains pellicle to each ounce of distilled water, and allow them to stand in a bottle. When levelled, dissolve by aid of heat, and shake. The plate is warmed, and the solution poured on it as with collodion, and returned to the bottle, and is then placed on a level shelf or table, and the gelatine allowed to set. It is finally dried in a drying closet, the operation being accomplished in about two to three hours.

Exposure.—These plates are very rapid, being equal to wet plates, and the addition of an excess of silver salt, which is soluble in ammonia, has been found by the writer to make them excessively sensitive. A half grain of benzoate of ammonia to each ounce of solution before washing was hence found to give great aid.

For Kennett's rapid plates, and for the plates prepared with an excess of silver in the shape of the benzoate, the following mode of development is adopted.

1.—Pyrogallic acid	...	...	...	4 grains
Distilled water	...	...	...	1 ounce

2.—Bromide of potassium	1 drachm
Water	8 ounces
3.—Bromide of potassium	20 grains
Water	10 ounces
4.—Ammonia	1 drachm
Water	8 ounces
5.—Gelatine*	20 grains
Water	10 ounces

(It is better to mix Nos. 2 and 4 together.)

The plate is first allowed to soak for five minutes in a dish of No. 3. (It is advantageous to keep the temperature up 60°.) To this solution in the dish is next added one ounce of No. 5, and after well soaking the plate is drained, and the developing solution applied. To every ounce of No. 1, one drachm of the mixed 2 and 4 is added, and flowed over the surface. The detail should appear gradually and quietly. When well out, more of Nos. 2 and 4 may be added till sufficient density is obtained. In case the whites still are too transparent, the ordinary pyrogallic intensifier (page 22) may be resorted to. For perfectly neutral plates the development is carried out in a similar manner, with the exception of the preliminary soaking in No. 3, for which plain distilled water is substituted. The fixing solution is usually sodium hyposulphite (see page 26). The plates and pellicle are supplied by Mr. R. Kennett, 8, Maddox Street, Regent Street, London, and full particulars are issued with both for development.

The colour of the deposit on these plates is very deceptive, being of an olive green tint, and the absolute density is not nearly so great as ordinarily requisite with dry plates. The development must take place in *very subdued light*, as the emulsion is excessively sensitive even to orange, and slightly to red light. Blisters sometimes make their appearance, through the water used in developing being too cold. The great advantage of the gelatine film seems to lie in its extreme sensitiveness.

PAPER NEGATIVE PROCESSES.

The following are modifications of the original calotype process, which has yielded excellent results in many hands. They are therefore given in detail. Large pictures may be produced

* The gelatine is swelled and dissolved in the usual manner.

by it which can *very nearly* bear comparison with those produced with wet plate negatives. Calotype is convenient, owing to the small weight that it is necessary to carry.

BUCKLE'S PROCESS.

The following process is the best of a variety:—

No. 1.—Silver nitrate ... ... 35 grains
Distilled or purified water ... ½ ounce
No. 2.—Potassium iodide ... ... 35 grains
Distilled water ... ... ½ ounce

Mix these two solutions,* and a precipitate will be formed, and if the above proportions of water be maintained the precipitate will retain a more solid and condensed nature, separating itself more readily from the supernatant fluid than would be the case if deficient quantities were used. The deposit of silver iodide should be washed in small quantities of water (one ounce to each washing being sufficient), as large quantities divide the deposit too finely. The method of washing is as follows. The supernatant fluid should be carefully decanted from the iodide, the fresh water should next be added, and the deposit briskly stirred in it with a glass rod. When well settled the water should be decanted off as before. The operation of washing should be repeated three or four times.

The iodide must now be redissolved by a solution of iodide of potassium in two ounces of water. The best way of effecting this is to place the precipitated silver iodide in a two-ounce measure with the two ounces of water and six drachms of potassium iodide. This will not effect the solution of the silver iodide, but extra crystals of the potassium salt should be added till it is complete—that is, till the liquid is just *not* clear (*i.e.*, in a semi-transparent state). Should this solution of iodide of silver be too powerful and too thick when coating the paper (which can be known by its deep sulphur colour instead of pale primrose on the paper), two-and-a-half ounces of water may be used instead of the two ounces.

The paper to be used should be as tough and grainless as possible. Turner's paper was the best suited for the process,

* The potassium iodide solution should invariably be poured on the silver nitrate solution.

but at present it is not procurable. Good English paper of the consistency of medium Saxe answers as a substitute.

Cut the sheet of paper into convenient sizes, and pin it by its corners on to a flat smooth board. Apply the solution with a flat cotton wool brush (or a brush as described for coating plates with a preliminary coating of albumen in the dry plate processes) evenly and plentifully. Let it dry partially. Next wash the sheet in rain water, taking care to expel all air-bubbles, and, having agitated it, leave it in the water whilst a second sheet is coated. When this second sheet is ready for immersion, withdraw the first sheet from the pan and place it in a second dish (likewise containing rain water), and place the second sheet in the first pan, and so on. When well washed in the second pan the paper ought to assume a bright uniform yellow colour, tending to green. The washing will take from one to two hours. Pour off the rain-water and rinse two or three times, drain, and hang them up by one corner to dry.

The paper in this state is nearly insensitive to light, and can be kept between leaves of a book or blotting-paper.

In a dark room pin the paper to a board, as before described, having previously prepared—

No. 1.—Silver nitrate	...	...	50 grains
Distilled water	...	...	1 ounce
Glacial acetic acid	...	...	80 minims

No. 2.—*Saturated solution of gallic acid in distilled water.

Take six drops of No. 1, to it add six drachms of distilled water, next add six drops of No. 2, and finally add from one to three drachms† of distilled water again. The mixture should then be well stirred with a glass rod. Apply this solution lightly, but plentifully, with the cotton (or other brush) to the iodized paper, blot off the sheets in succession, and place two back to back with blotting-paper between them.

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* A stock bottle of gallic acid may be kept, filling up with water, and shaking well after any of the solution is taken out. If all air be excluded from the bottle, it will not turn brown or discolour.

† Heat quickly decomposes a strong solution of Nos. 1 and 2, consequently the greater the heat, the larger should be the quantity of water added. This method of mixing also prevents their instantaneous decomposition.

In very hot climates, twelve drops of No. 1 and seven of No. 2 may be substituted with advantage for the proportions given above.

A plate of glass of the size of the inside of the camera slide, and having the thickness of the supporting silver wires, having been selected, the corners should be broken off. The glass should then be placed in the frame; the back surface of it will now be on a level with the inside of the silver wires. On this plate place the sensitized paper, and back it with another glass plate. The paper will, when in the camera, coincide with the front of the ground glass. By attaching the corners of the paper by gum to one glass plate the use of the second may be avoided.

For a fifteen-inch focal distance single landscape lens, full aperture, three minutes in bright light will suffice. This may give some sort of a guide for exposure with other lenses.

Take the paper out of the dark slide, and pin it on the board as before. Apply equal parts of Nos. 1 and 2, with equal quantities of water, with the brush, and allow the developing action to proceed until it begins to flag. Next apply the solution of gallic acid *very* lightly until the deep shadows begin to dim by transmitted light. The development must then stop, otherwise fog will ensue. This, however, may be arrested by placing the paper face downwards in three or four changes of water, allowing a quarter to half an hour between each change. If, on opening the dark frame, the image on the paper appear perfectly defined, and of a dimly red tint, it is a sign that the exposure has been too long. In this case use one part of No. 1 to two parts of No. 2. Should under-exposure be suspected, two parts No. 1 to one part of No. 2 should be the proportions used. On foliage or dark shadows which do not develop readily, the same proportions of Nos. 1 and 2 should be applied. The brush should then be dipped in the solution containing the ordinary proportions, and be passed over these, together with the other parts, to equalize the development, and to prevent marks arising from the use of the different proportions.

The negative is fixed by immersing the developed picture in

Sodium hyposulphite	...	...	2	ounces
Water			32	,,

The fixing is complete when all the yellow of the iodide has

disappeared. This will usually take about half an hour. The paper negative must be washed for two or three hours in running, or frequent changes of, water, and dried spontaneously.

The negative, when dried, is ready for waxing. A flat iron should be warmed, and a small cake of pure white wax be brought in contact on the back of the negative with its point. The heat melts the wax, and, by moving the iron, the melted wax can be spread over any desired portion of the picture. Blotting-paper should be then placed over the negative, and the hot iron passed over the surface of the blotting-paper till all superfluous wax be removed. The negative is now fit for printing purposes.

It is usual to wax the whole of the negative, with the exception of the sky. Unless the sky be very dense, any portion of it that has been waxed will have to be rendered opaque with indian-ink or some equivalent.

Sensitized calotype paper will only keep two or three days. The quicker it be employed after sensitizing the better will be the result. The paper which has been coated with iodide, but not sensitized, will keep for an indefinite period if protected from light.

GREENLAW'S PROCESS.*

First examine and select thin negative paper, and reject all that show any irregularities, holes, patches of unequal density, &c.; that recommended for Buckle's process will answer.

Make a solution of—

Potassium iodide	...	...	1,000 grains
Potassium bromide	...	...	300 ,,

(For much foliage the latter may be increased to 450 grains.)

Distilled water	...	...	40 ounces

and add enough of pure iodine to give the solution a dark claret colour. Then filter.

Into this place as many sheets of paper as you can with ease, being careful that no air-bubbles exist. Allow the paper so immersed to rest for one hour; then turn the whole upside down, and hang the sheets up to dry, taking off the last drops with white blotting-paper. This may be done in diffused light.

* Taken from the YEAR-BOOK OF PHOTOGRAPHY for 1870.

When dry, place sheet over sheet evenly in a portfolio in which no other papers, except blotting-paper, are placed. They will then be iodized a dark purple, which will keep any time. They, however, turn a light brown colour. Be sure, in working, that nothing touches the paper, for the very slightest touch will cause a stain in the development.

Silver nitrate ...	...	...	$2\frac{1}{2}$ ounces
Glacial acetic acid	...	...	$2\frac{1}{2}$,,
Distilled water	...	...	40 ,,

Now float a sheet of your iodized paper on this (smooth side downwards) until the purple shall have turned an uniform yellow, which is silver iodide. Allow it to rest for one minute; after this, remove and immerse in distilled water, where it should remain for two or three minutes; if to be kept for some time, remove to another dish of distilled water. Place now on clean white blotting-paper, face upward, and remove by blotting-paper *all* moisture from the surface (these sheets can be again used for ironing out the wax by-and-bye); then place between blotting-paper, or hang up to dry; when *quite* dry, place in your dark slides.

Gallic acid ...	...	...	200 grains
Spirit of camphor	...	...	1 drachm
Distilled water	...	...	40 ounces

This is a saturated solution of gallic acid; unless preserved from the air it decomposes; the spirit of camphor is added to preserve it. When about to develop, filter, and add to every five ounces one drachm of the following solution:—

Silver nitrate ...	...	...	30 grains
Glacial acetic acid	...	...	$\frac{3}{4}$ drachm
Distilled water...	...	...	1 ounce

Pour into your dish quickly, and *immediately* float the picture side of your paper, which is slightly visible on it, being very careful that there be sufficient liquid to prevent the paper touching the bottom of the dish. Constantly watch until the picture becomes visible on the back, and the paper has a kind of brown, greasy appearance. Continue the development until, in holding up a corner when the sky is before the light, you cannot see your finger when moved about between the light and the paper. If it be not dark enough before the silver gallate

decomposes, you have under-exposed. Decomposed gallate of silver ceases to develop.

Do not, when examining your paper, lift more than the corner, as an oxide of gallate of silver forms *rapidly* on the surface like a crust, and, on replacing your picture, it causes innumerable marble appearances; as also if you do not place your paper speedily on the solution in the first instance. It may be removed by drawing a sheet of blotting-paper over the surface of the solution. Remove to a dish of common water, and wash out the brown tinge caused by more or less decomposed gallate of silver.

When *well* washed, you may fix it by placing it in solution of sodium hyposulphite, one and a-half ounce to one pint of water, till every vestige of the yellow silver iodide be removed, after which wash in eight or ten different changes of water; you have then a fine, clear, and dense negative.

MISCELLANEOUS APPLICATIONS OF PHOTOGRAPHY.

INSTANTANEOUS PICTURES.

The term "instantaneous" is merely a comparative term, and must be understood as expressing simply a *very* short exposure. In photographing street scenes, &c., short exposures are of the greatest use, and there are frequently occasions in art photography in which an accurate knowledge of the conditions for obtaining instantaneous pictures is essential.

The plates must be excessively clean, as the shortness of the exposure and the strength of the developer used render the slightest chemical dirt apparent.

A collodion containing a large amount of bromide is generally used, and it should be of a straw colour to give the best results. The addition of 1 to 1½ grains of bromide to the ounce of ordinary bromo-iodized collodion is advisable as a rule. It is recommended that the different samples of iodized collodion in stock should be tested one against the other, by means of the cut stereoscopic plate (as described at page 12), and the most rapid and delicate selected.

A newly prepared bath (or nearly so) is an essential: the 40-grain (as described in page 15) will answer; a 50-grain bath will, however, ensure better results. With a highly-bromized

collodion, the addition of a drop of concentrated nitric acid to the ounce of bath will often aid sensitiveness; with a collodion poor in bromide this addition must not be made. If doubt exist as to the quantity of bromide, the more neutral condition of the bath had better be maintained.

The iron developer No. 3 (page 18) is suitable. Two other formulæ are given, both of which are effective.

Ferrous sulphate	60 grains
Water	1 ounce

Or,

Ferrous sulphate	60 grains
Formic acid	$1\frac{1}{4}$ drachms
Alcohol	*quant. suff.*
Water	1 ounce

A pyrogallic acid solution has also been used, viz.:—

Pyrogallic acid	20 grains
Formic acid	1 ounce
Alcohol	6 drachms
Water	1 ounce

It is of the greatest importance that the plate should be covered with the developer quickly. It matters little in this case if part of the free silver solution be washed away by the developer; in fact, it is advisable, as the lack of silver prevents too great a reduction on the higher lights before the detail is brought out.

It generally happens that instantaneous pictures require no intensification. If they should require it, the iron and citric acid formula is recommended, as it brings out detail. Care must be taken that harshness is not given to the negative from trying to force out detail, and only really piling up the silver on the high lights without bringing up the half tones.

With bath dry plates instantaneous pictures can be obtained, though with less certainty than by the wet process. The great essential with these is that they should be freshly prepared, and be raised previous to development to a temperature of about 100° Fah. This may be managed by immersing them in water of that degree of heat. The developer should likewise be warmed to the same temperature. England's collodio-albumen process has answered well with the writer, the above precautions being

taken. With Col. Wortley's uranium dry plates the ordinary mode of development may be adopted, using a larger dose of the ammoniacal solution. Rapid gelatine plates (page 84) have been successfully employed.

A short-focus lens, having a good defining power, with a large stop, should be preferred. A single lens has the additional advantage of having the smallest number of reflecting surfaces.

As examples of doublet lenses which are suited for copying, Dallmeyer's rapid rectilinear, Ross's symmetrical, and ordinary doublet may be mentioned.

The best subjects for instantaneous photography are those in which there is but little contrast. Sea pieces and clouds form objects most suitable for artistic purposes. Trees are rarely rendered satisfactorily, owing to their non-actinic colour.

PHOTOGRAPHING THE INTERIOR OF BUILDINGS.

Interiors are often most interesting subjects for the camera. A few hints on the manipulations, &c., when wet plates are used for photographing such subjects, are given.

A collodion which has been iodized long enough to assume a dark straw colour, and to which a grain of bromide of cadmium has been used to each ounce, should be employed. Some photographers employ two collodions, one newly-iodized, and the other very old. A first coating is given with the new, and, after setting, a subsequent one is given with the other.

The plate should be coated as usual; but on immersion in the bath it should be kept in rather violent motion till all the greasiness has disappeared (which will be in about two minutes). It should then be taken out very slowly, so as to drain completely. Damp blotting-paper should be placed at its back, and the droppings absorbed in the slide by a strip placed at the lower edge. The plate may, by this method, be exposed for a long time (two or three hours) without staining or drying. The rationale of this is as follows:—The plate is kept in the bath long enough to change the iodizers into iodide of silver, whilst the *bromide* of silver is only partially formed. The free nitrate of silver left on the plate is absorbed by the bromizers to complete the change. This prevents the crystallization of the nitrate of silver on the film. The *nitrates* of cadmium, &c., formed, being very deliquescent, retain sufficient moisture to prevent the film drying.

The exposure for an interior can rarely be too long. The same rule holds good as in ordinary wet-plate photography, viz., expose for the detail in the shadows.

If the sun shines into the windows of the building, the light may advantageously be used, by the use of a looking-glass or tin reflector. Those parts in the deepest shadows are those to be illuminated by reflected light. The reflector should always be kept moving about, otherwise an opaque patch will be produced on the negative. Magnesium wire may be burnt in one of Solomon's lamps, to take the place of the sunlight, the same method of procedure being adopted. When a window through which white light is pouring has to be included in the picture, a yellow cloth or blind should be placed over it till the exposure is nearly complete. This prevents halation or blurring.

No. 3. Developer (page 18) should be used, the contrasts between the high lights and deep shadows being *usually* extremely marked.

Intensification is rarely necessary; if it be, the ordinary formulæ are recommended.

It may happen, no matter what care is taken, that markings like slug tracks and oyster shells show with development. These may be caused by using too strong a bath, and also by the drying of the film. Generally they may be obliterated by brushing a fine tuft of cotton wool over the defective spots, either when the film is damp and kept covered with water, or when dry. The latter condition is the safer.

The removal of the markings should, in all cases, precede intensification, as the silver deposited on them by means of the intensifier would be brushed off. This would leave the negative intensified at all parts except on those from which the deposits had been brushed.

Another method, that has been suggested by Mr. Jabez Hughes, is to wash the plates after sensitizing, and after exposure to re-dip them.

The plate, after having been fully sensitized, is placed in a dish of distilled water, and washed till all greasiness disappears. It is then drained, and placed in the slide, with blotting-paper at the back. After exposure, the plate is re-dipped in the bath for at least a minute, when it is developed in the usual manner.

Another method is to wash the plate thoroughly after sensitizing, and float over it any of the given preservatives for dry processes, and develop by the alkaline or gelatino-iron

development. Perhaps the most simple preservative to employ is a wash of beer to which one grain per ounce of pyrogallic acid has been added.

COPYING PLANS, ENGRAVINGS, ETC.

A most important branch of photography is the copying of plans, sketches, &c. The greatest care should be exercised in the selection of lens and chemicals for the operation, success depending mainly upon them.

No single lens should be used, owing to the curvature given to the marginal straight lines. This confines the choice to the landscape, doublet, and triplet, and to portrait combinations. Of these the doublets are the most satisfactory. With lenses obtained from first-class makers there is no distortion; the reflecting surfaces are fewer in number than in the triplet combination, and therefore it is to be preferred. The triplet seems to have a flatter field; in bright weather, therefore, when there is plenty of actinic light, it may be used with advantage. The triplet and doublet mentioned may be considered, *par excellence*, the copying lenses. Portrait combinations also answer; the general objection to them, however, is that the image is so concave as to be out of focus at the margin, unless one of large diameter be used. Dallmeyer's D lenses have less of this objection. With a large stop they answer for portraits, whilst with a smaller one they answer for copying purposes. No. 6 D lens, by the above maker, will answer for copying plans on an 18 by 15 plate. If a lens of this size be not at hand, the above maker's rapid rectilinear or triplet (for 18 by 15) may be substituted.

If the plan have to be reduced by photography with the aid of a portrait combination, it is preferable to have the front lens next the plan to be copied; if it have to be enlarged, the combination should be inverted, and the back lens placed in front.

Unless a special camera be employed, the rendering the image of the plan, &c., to be copied of a particular size entails considerable labour in shifting the board on which the plan, &c., should be fixed.

The following mode of attaining parallelism to the focussing screen answers well. On the centre of the board on which the drawing, &c., is to be fixed, a small mirror may be temporarily fixed. This latter should be strictly parallel to the surface of the board. The point corresponding to the centre of the lens should be accurately marked on the ground glass. On the lens

itself an open cap should be fitted, furnished with two cross threads, intersecting on the prolongation of the axis of the lens. The image of these cross threads will be reflected by the mirror, and should be focussed. The board should then be tilted or slewed round till the image of their intersection coincides with the point marked on the ground glass.

The board will now be parallel to the ground glass; the mirror being removed, the drawing may be fixed on to it, and focussed as usual. A neat stand for the board will readily suggest itself, by which it may be moved parallel to the position thus fixed, so that the distance necessary to give the exact size required may be attained.

The mirror may be let in flush with the board, thus obviating the necessity of its removal for fixing up the drawing.

A direct light, coming in an horizontal direction, is generally to be preferred for copying, as the texture of the paper is hidden by it. If a vertical light be used, the shadows of the irregularities on the surface of the paper, being copied, may mar the purity of the whites.* Should the plan be shaded in flat tint, it may be necessary to copy it in direct sunlight, as Indian ink and sepia, and some other colours, are of such a non-actinic nature as to make but slight impression on the sensitive film; strong light lightens up the shades, which are only dark by comparison. For like reasons, plans or engravings on paper which, through age or other causes, has turned yellow, should be copied, if possible, in a similar light.

The light for copying oil pictures should come from the direction in which the light has been supposed to come in the picture itself. A painter "loads" his canvas in such a manner as to give the best effect to his picture when viewed in that particular light.

For copying pictures in plain black and white, a simple iodized collodion is recommended by many skilful photographers. In practice it has been found that a bromo-iodized collodion yielding intense negatives answers well for ordinary work. The addition of a grain or two of pyroxyline (or, better still, papyroxyline) which has been washed in dilute ammonia will often cause a limpid collodion to become fit for copying purposes.

* In copying certain classes of drawings the writer has found that light admitted through a funnel-shaped box, formed of tissue-paper stretched on laths, prevents the irregularities of the paper showing. In copying prints from albumenized paper, &c., the same procedure may be followed.

The alkaline reaction in collodion gives intensity, and this is further increased by the addition of the pyroxyline. If a painting, either in monochrome or colours, have to be reproduced, the ordinary bromo-iodized collodion is recommended.

The bath should be free from any impurity, and may be of the ordinary strength.

For plans or line drawings, developers Nos. 1 and 8 (pages 18 and 19) are recommended. The iron may be used even weaker than in No. 1, and may be as follows:—

Ferrous sulphate	5 grains
Glacial acetic acid	10 minims
Alcohol	*quant. suf.*
Water	1 ounce

With a simple iodized collodion, pyrogallic acid may be resorted to as a developer. Should this be decided upon, half the acetic acid given (formula, page 17) should be added, otherwise the deposit may become too crystalline in form. In winter, or when the light is weak, the iron developer should invariably be employed.

For ordinary paintings a twenty-grain developer may be taken as a standard solution; a stronger or weaker one may be necessary, according as great or little contrast is desired.

Negatives of plans drawn in lines should never be fully developed, and they should be slightly under-exposed. When the reduction on the whites has taken place, the developer should be washed off and the negative fixed. By this method deposit on the lines is avoided.

The negatives will require intensification. In rare instances the simple application of the iodine solution (page 22), followed by the pyrogallic intensifier, will suffice. Should this, however, not give sufficient density, either Nos. 6, 7, or 8 (page 22) may be tried in addition. The last three should be again followed (after the negative has been well washed) by 9, 10, or 11. If No. 6 be used, the negative should be placed in the sunlight for two or three days, when it will be found that the whites have become perfectly non-actinic.

With No. 7 it is convenient to immerse the negative in the solution contained in a flat dish, and it should be left till the film has acquired a white appearance by transmitted and reflected light. If, after Nos. 9, 10, or 11, shall have been applied, the

whites are not sufficiently dense, pyrogallic acid intensifiers may be applied, and after intensification proceeded with as before.

It requires considerable practice in manipulation to prevent (1st) a deposit forming on the lines from the pyrogallic acid intensification, or (2nd) the lines from becoming filled up by the deposit of mercury and silver.

It is safer, after using a solution of mercury, to let the negative dry spontaneously. Rapid drying is apt to cause the film to split.

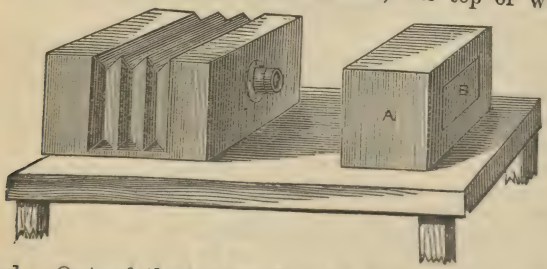
The ordinary procedure of wet-plate intensification should be carried out in copying paintings.

For copying, it is useful to know the equivalent focus of a lens, as by it the distance of a plan, &c., from the lens may be known. To determine it, see Appendix.

PRODUCTION OF TRANSPARENCIES.

The production of positive transparencies on glass from a negative is necessary, as a rule, for the multiplication of negatives, reversed or otherwise. The following are modes of oduction by the camera or by contact printing.

When it is determined to use the camera, if a proper copying camera be not at hand, the following substitute may be employed. A is any ordinary rough box, the top of which is



removed. Out of the bottom is cut a rectangular portion, B, just large enough to hold the negative from which the transparency is to be obtained. Small pieces of wire are placed across the angles to support the face of the negative. When the latter is placed in position, a couple of pins inserted at the top and bottom of the outside of the opening will prevent it from slipping. Placed as shown in the figure, with the light from the

sky showing on B, or else reflected through it by a mirror or a perfectly smooth sheet of white paper, a transparency may be obtained merely by treating the negative as if it were a place, &c., to be photographed. It has usually been considered that the box holding the negative and the camera ought to be connected together, no diffused light having access to the front of negative. In practice this is found unnecessary, and where the negative is dense the diffused light is absolutely an improvement. Should it be very weak, a couple of battens placed across the interval, and a cloth thrown over it, will exclude all extraneous light.

Another mode of obtaining transparencies is by using an opening (through an outside wall) in the dark room to hold the negative, and placing a table level with it to hold the camera. A mirror placed at about 45° with the horizon, and covered over with plate glass as a protection from dust and rain, reflects the clear light of the sky through the negative.

It need scarcely be said that the focussing should be *very carefully* attended to; a common pocket magnifier is useful to attain extreme definition on the ground glass.

The negative for a brilliant transparency should be slightly less dense, if possible, than for good printing. It is, however, by no means to be inferred that a negative of even great density cannot be copied, but only to be understood that this class will give the finest results.

The use of a highly-bromized collodion is to be recommended. For ordinary printing-negatives the addition of one grain of bromide to the ounce will suffice; for a negative of the weak type the bromide may be omitted; whilst for a dense negative the bromide may be added up to three grains per ounce. The bromide should be added five or six hours before the collodion is required.

The exposure should be long enough to cause the *minutest* detail in the negative to be apparent in the transparency. On drying, the points of bare glass should be very few; if it be not so, it may be taken for granted that the exposure is too short. No fixed rules can be laid down for the length of exposure; the operator must use his judgment.

The development is carried on with a very weak developer, the strength varying with the density of the negative to be reproduced; the denser the negative, the stronger the developer

should be. For a negative of medium density the following may be used:—

Ferrous sulphate	5 grains
Glacial acetic acid	5 minims
Alcohol	*quant. suf.*
Water	1 ounce

For a *very* dense negative the ordinary 20-grain iron developer (page 18) may be used. Should there be too much contrast, add more bromide to the collodion, and use a stronger developer; if too little, diminish the quantity of bromide, and use the weak developer. Intensification may be carried on to such a point that on looking through the glass the *deepest* shadow appears nearly opaque.

The transparencies should be fixed with sodium hyposulphite (see page 26), in order that the delicate details may not be eaten away in the slightest degree.

The ordinary colour given by silver is not an agreeable one, and it is generally necessary to tone the image. This may be effected by a platinum salt, a gold salt, or iridium salt, or by a mixture of any or all of them. The formulæ are as follows:—

No. 1.—Ten-grain solution of platinum-tetra-chloride	1 drachm
Nitric acid	12 drops
Water	10 ounces
No. 2.—Gold tri-chloride	1 grain
Hydrochloric acid	6 drops
Water	10 ounces
No. 3.—Iridium chloride	1 grain
Hydrochloric acid	12 drops
Water	10 ounces

If a mixture in equal quantities by measure of Nos. 1 and 2 be taken and flowed over the plate, a pleasing tone will be given. When toning with gold a pink deposit is apt to form on the transparent portions, which spoils the effect. Sometimes the platinum solution by itself will give rather an inky colour.

Transparencies may also be made by placing dry plates in contact with the negative in any ordinary printing frame. The exposure may be made by opening the windows in the dark room for a very short time (varying from half a second to

twenty seconds in dull weather), or it may be given by the light from a strong gas jet. With an Argand burner of 12-candle power, and with the frame six inches from it, an exposure of from six seconds to six minutes will be required, according to the sensitiveness of the plate for the particular light employed. With gum-gallic plates the colour given by development (if double the quantity of gelatine solution be added to the iron) will be generally of a warm black, which needs no toning.

The collodio-chloride process may also be adopted. A glass plate should be albumenized round the edges, as for dry processes, and is coated with the collodio-chloride (page 126). When dry, the film is fumed by holding it over the mouth of a bottle containing ammonia, and moving it till the entire surface has received the vapour. The plate is now brought into contact with the negative in a pressure frame. If strips of paper be gummed on to the corners of each plate, it may be examined without danger of loss of register during printing; otherwise a tolerable guess may be made of the progress of exposure by opening half the frame and looking through the two plates. It will be found that the print on the collodio-chloride is not possessed of sufficient vigour. The necessary amount is given by flooding it with—

Gallic acid	75 grains
Lead acetate	50 ,,
Acetic acid	2 drachms
Water	20 ounces

To this a few drops of a twenty-grain solution of silver nitrate should be added. When the intensity* is sufficient, the plate is washed, and then fixed with weak sodium hyposulphate. The image may be toned as given above.

Another method of producing transparencies is by carbon printing. The gelatine is transferred to glass (which has had a slight trace of waxing solution rubbed over it) instead of to the zinc plate. The picture in this case will be reversed,†

* The intensity increases on drying, therefore a certain allowance must be made.

† In producing transparencies in the camera, the same reversal may be effected by turning the film-side of the negative away from the lens. The glass must be absolutely free from flaws to give a perfect result.

which is an advantage in mounting, as the ground-glass protects the film.

In mounting a transparency, some translucent substance must be placed behind it. Ground-glass is usually employed, the rough surface being placed on the outside. Another better method is to dissolve to saturation white wax in ether. Filter, and to each ounce of solution add another ounce of ether. Flow over the silver side, and allow to dry. After twenty-four hours the wax will give a beautiful transparency to the picture. With all except the carbon transparencies, the following may be substituted:—

Flake gelatine	2 ounces
Glycerine	¼ ounce
Water	6 ounces

The gelatine should be allowed to soak in cold water till it is thoroughly swelled, and then dissolved by placing the vessel containing it in hot water. Just previous to use, sufficient of the solution should be taken, and to the above amount two ounces of new milk be added, heated to 90° F.; the whole to be stirred together well with a glass rod, and sufficient of the mixture poured from a measure or jug through fine muslin to cover the plate, which must have been *accurately* levelled. It should be allowed to set, and then be dried spontaneously in a warm room. If the transparency be reversed the gelatine should be poured on the film side. When thoroughly dried (in the last case) the film may be stripped off, and it will carry the collodion pellicle with it. The picture may be cut out and bent to any form after varnishing; for instance, lamp-shades may be composed of a set of prints thus produced.

If two hundred grains of zinc oxide replace the milk, we have Mr. Burgess's Eburneum process. The solution, with the oxide added, should be kept warm, and allowed to stand six or eight hours before being allowed to solidify. The frothy top-layer, and the bottom layer containing the coarse particles, are removed, and the solution is to be re-melted and poured on the plate as above. About four ounces of solution should cover a 12 by 10 plate.

REPRODUCTION OF NEGATIVES.

In all cases (excepting when the reproduced negative is to be reversed) a rather thin transparency must first be made. Any

of the methods given in the last article may be adopted. The transparency is treated in the same way as the negative. From a carbon transparency, however, a negative cannot be made by contact printing, as, being raised in the high lights, the surface of the dry plate or collodio-chloride film is prevented from being in contact with the picture. It will be noticed that enlarged negatives can be produced either by making an enlarged transparency, or by enlarging the negative from it in the camera. In all cases of enlargement the camera must be employed for one or the other; but it is strongly recommended that the transparency be enlarged, as then only those defects due to the negative are magnified. The one exceptional case where a negative can be reproduced without a preliminary transparency is by the collodio-bromide process. The negative should be placed in the carrier in front of the lens, with the film side outwards. If a dry collodio-bromide plate be used, it is exposed and developed by the alkaline method, the development being carried on to such a point that the metallic (or oxide of) silver is apparent, in the deepest shades, by reflected light at the back of the plate.

A trace of fog is not objectionable, if the negative to be copied be very dense. *The plate is not fixed,* but dilute nitric acid (one of acid to one of water answers) is poured over the film. This dissolves away the reduced silver, and leaves a negative image formed of silver bromide. The plate is well washed, and a very dilute solution of ammonia is floated over the film to neutralize any acid. After washing thoroughly, the plate is taken into the light, and developed with the alkaline developer once more. This reduces the silver bromide to the metallic state, and gives the required negative. If too weak, the image may be intensified with pyrogallic acid and silver, as for a wet plate.

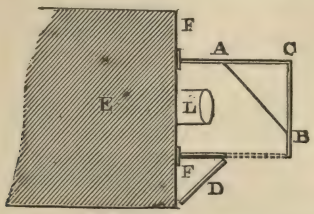
The same procedure is taken if wet bromide of silver be used. A plate is treated with collodion containing eight grains to the ounce of cadmium bromide ammonium, or a proportion of each. It is sensitized in an eighty-grain bath for ten minutes, or the forty-grain bath for twenty minutes. After thorough washing, any one of the preservative solutions given for dry plates is flowed over it, and the exposure takes place whilst it is wet. The ordinary alkaline development is then proceeded with, and the remaining operations are as above described.

REVERSED NEGATIVES.

For photo-mechanical printing, and single transfer carbon printing, reversed negatives are essential. Their production may be divided into three classes:—1st, reversed negatives taken in the camera; 2nd, negatives reversed by reversing the collodion films of the originals; 3rd, reproduction from other negatives.

In the first case, the negative should be taken by means of a reflector, from a flat plate or glass silvered externally.

The accompanying sketch gives an idea of what is required.

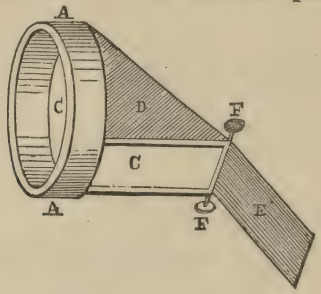


E is the camera; L the lens; A C B D is the section of a hood round which is fitted a flange (FF) which can be screwed into the camera. A B is a mirror, as above described, which is placed at an angle of 45° with the axis of the lens, and so placed that the centre of the mirror is its continuation; D is a small door, which can be opened or shut at pleasure. The object to be photographed is reflected from A B to the lens, and a little consideration will show that the image on the focussing screen will give a reversed negative.

The mode of silvering the mirrors is given in the Appendix. Another plan of obtaining a reversed image is by using a right-angled prism fitted on to the lens.

A A is a flange that fits on the lens, taking the place of the cap; C C is a right-angled glass prism, whose breadth is equal to or greater than the diameter of the front glass of the lens. All the surfaces are enclosed in brass mounting, excepting C C, care being taken that the surface enclosing the right angle is not in contact with the surface of the glass; E is a shutter for exposure; F F, screws for clamping E.

The image undergoes total reflection by the prism, and this gives a reversed negative. There is no particular rule for



using either the mirror or the prism, excepting that both should be free from dust, and the former from tarnish as well.

An ordinary negative may be reversed by transferring the film. The best method is that of coating it, whilst unvarnished, with a solution of india-rubber in benzole, of the consistency of collodion* (india-rubber paste dissolves readily in this menstruum). When drained, it is allowed to dry. Transfer collodion, made as follows, should then be flowed over the surface, and allowed to dry thoroughly:—

Ether	5 ounces
Alcohol ·805	10 ,,
Castor oil	¼ ounce
Pyroxyline	¼ ,,

The plate should then be immersed in cold water for a few minutes, or until the film seems to become loose. Should this not take place in reasonable time, one ounce of sulphuric acid may be added to each gallon of water, which will aid the detachment. The film should be cut with a penknife round the edges, and should be stripped off gently whilst in the water. It should then be turned over and laid on a clean plate (or one slightly gelatinized, see page 55) whilst still floating. A soft squeegee, as for carbon printing, may then be used to expel the liquid between the two surfaces, and the plate should be set aside to dry. It may be varnished and used as an ordinary negative.

* About one grain to two grains to the ounce.

Reversed negatives may be produced from other negatives by the processes mentioned in the last article. They may also be produced by placing dry collodio-bromide plates *in contact* with the negatives, dissolving away the image with nitric acid before fixing, and proceeding as before shown. Also see Powder Process.

PAPER ENLARGEMENTS BY DEVELOPMENT.

Albumenized paper should be sensitized in the following bath :—

Silver nitrate	... 40 grains
Glacial acetic acid	... 30 minims
Water	... 1 ounce

and developed with gallic acid.

The gallic acid solution may be made as follows :—

Gallic acid	... 3 grains
Acetic acid	... 5 minims
Water	... 1 ounce.

The paper is immersed in a dish of this fluid, and the development takes place rapidly if properly exposed. Remembering that it is a positive print that is required, the purity of the whites must be preserved, and the development stopped before any deposit takes place on the highest light. When properly developed the print should be taken from the developing dish, and *well washed*. Any of the ordinary toning baths will give it an agreeable tone. It should be fixed, as usual, with sodium hyposulphite and water.

Plain paper may be salted with—

Sodium chloride	... 100 grains
Hydrochloric acid	... 6 minims
Water	... 12 ounces

The paper is immersed for two or three hours, and then dried. It is then floated for three minutes on a solution of silver :—

Silver nitrate	... 1 ounce
Citric acid	... 8 grains
Water (distilled)	... 8 ounces

When moderately dry, the paper is exposed as before, by pinning it on a board, and placing it, after focussing, in the

camera or its substitute. A *faint* image of the negative should be visible, and then it may be developed by—

Pyrogallic acid	2 grains
Citric acid	1 grain
Water	1 ounce

Sufficient of this must be taken to well cover the paper (which should previously have been stretched on a glass plate, by turning the edges underneath it); in the flow no stoppage must be allowed whilst covering the surface. As soon as the proper contrast is obtained, the paper is well washed, and, if necessary, toned. The prints are finally fixed in—

Sodium hyposulphite	1 ounce
Water	16 ounces.

They are kept in this till the high lights lose any trace of colour; they are then withdrawn from the solution, and washed in the ordinary manner (page 122).

Artistic *enlargements* are also produced by taking an enlarged transparency of the negative and printing it on ordinary albumenized or salted paper to a depth beyond that ordinarily necessary for silver printing. (See "Silver Printing.") The print is then fixed, washed, dried, and waxed (as described at page 90) for the calotype process.

Enlargements on paper may also be effected by the calotype process, and call for no very special remark. A reversed paper positive, enlarged or otherwise, may also be obtained direct in the camera by a process due to Mr. Fox Talbot. Calotype paper is sensitized in the ordinary manner, exposed to light for a short time, then immersed in a solution of potassium iodide, and well washed. It is now exposed in the camera for ten minutes, and developed in the usual way with gallo-nitrate of silver. The resulting picture is a positive, supposing a positive has been copied. The same mode of procedure can be adopted with iodized plates.

SILVER PRINTING.

Silver chloride darkens when exposed to the action of sunlight. It assumes a deep violet tint, and, if it be immersed in water, traces of free chlorine will be found to have been liberated.

The light then, by its vibratory force, decomposes the molecule of silver chloride into a sub-chloride and chlorine gas. Chemically, it is expressed thus—

$$\overbrace{2Ag\,Cl}^{\text{Chloride of Silver.}} = \overbrace{Ag_2\,Cl}^{\text{Sub-chloride of Silver.}} + \overbrace{Cl}^{\text{Chlorine.}}$$

Silver chloride is formed by double decomposition, similarly to the iodide (see page 2). It is soluble in sodium hyposulphite, potassium cyanide, similarly to the silver iodide (as shown at page 25), and also in ammonia. When silver chloride has been acted upon by light, and the sub-chloride formed, the hyposulphite or other fixing agent re-converts the sub-chloride partially into silver chloride, and partially into metallic silver. Thus—

$$\overbrace{Ag_2\,Cl}^{\text{Sub-chloride of Silver.}} = \overbrace{Ag\,Cl}^{\text{Chloride of Silver.}} + \overbrace{Ag}^{\text{Silver.}}$$

The fixing agent dissolves the silver chloride, leaving the metallic silver unaltered.

When silver nitrate is brought in contact with an organic substance, the resulting compound is found to be affected by light in a somewhat peculiar way: the compound slowly darkens to a reddish tint; the exact chemical reaction that takes place is very complex to trace, but it may be accepted that an oxide of the organic matter and silver is formed. This oxide is stable, unlike the silver oxide, and is not acted on by fixing agents to any great extent.

It has been found that a certain proportion of the chloride in combination with the organic compound aids the rapidity of change of colour of the latter. If a paper be coated with albumen (say) in which has been dissolved a certain quantity of a soluble chloride, and floated on a silver solution, both chloride and albuminate of silver are formed. It depends, however, on the strength of the solution as to what proportions of each are present, owing to the fact that the organic compound is much slower in formation than the chloride, and has less affinity for the silver. If the silver solution be not sufficiently strong, the chloride may rob that portion of it with which it is in contact of all the silver before any (or, at all events, sufficient) albuminate has been formed, the molecule being composed almost entirely of silver chloride. The stronger the silver solution the more "organate" will it contain; whilst if it be very weak,

very little will be present. Hence it is that with albumenized paper which is weakly salted with a soluble chloride a weak sensitizing bath may be used, whilst if it be rich in the chloride it must be of proportionate strength.

One other chemical reaction in printing must be considered—viz., that of the free silver nitrate, which is always present. During printing, as stated, the silver chloride becomes reduced to a sub-chloride, evolving chlorine gas. This chlorine has a stronger affinity for silver than has the nitric acid (with which it is in combination in the silver nitrate), and, consequently, it combines with the silver, forming new silver chloride,* which, in its turn, enters into a combination with the organate, liberating nitric acid.

This freshly-formed organo-chloride, in its turn, blackens by the action of light, and adds to the strength of the image formed. If the free silver nitrate were absent, we should have the chlorine attacking the darkened organo-chloride of silver already formed,† and partially bleaching it. The result would be "measly" or mealy prints—*i.e.*, prints in which minute red spots alternate with darker ones in the shadows after fixing.

From the first part of this article it would be gathered that, as the silver sub-chloride is much more acted upon by a fixing agent than the product of the organate *after* it has been considerably affected by light, the molecules formed of the organo-chloride of silver, when only partially acted upon by light, would be much more easily attacked by the fixing agents than when fully acted upon. This is the case: the blacker an image formed by the organo-chloride becomes, the less it is attacked by the fixing agent. As a consequence, the half-tones of a picture are attacked by it proportionally more than the shadows.

The most important of the organic substances used in printing is albumen. It has been used hitherto in preference to any other organic compound, on account of the delicate film it forms on the paper free from all roughness, and also for the beautiful colour the print takes by the production of the albuminate of silver. The albumen should be used fresh, and in a slightly alkaline condition. The principal commercial objection to its employment in such a condition as the foundation of the picture

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* Probably together with hypochlorous acid.

† Thus, $Ag_2Cl + Cl = 2AgCl$, leaving the organate of silver coloured, whilst the subchloride of the molecule was bleached.

arises from the difficulty that is experienced in coating the paper evenly with it. Makers of paper prefer old albumen, which gives a slightly acid re-action. When in this last condition, the paper is easily coated, though the toning is retarded, and inferior pictures are the result.

Gelatine is the next important organic substance to be remarked upon. The organic silver compound formed with gelatine gives redder tones than the albuminate. In sizing it is frequently employed, and for pictures which it is intended should be of a reddish tone when printed, such paper may be used.

Starch imparts a more purple tint to the picture than the foregoing. Those papers sized with this substance yield the pictures, on toning, of a blue tint.

There are two kinds of paper principally used for albumenizing—Rive and Saxe. They both are starch-sized papers. The latter is much more porous, and consequently less glossy, than the former. Rive paper is, however, tender when wet, and tears easily when used in large pieces, such as required for large prints.

Saxe, therefore, is preferred for large prints, whilst the Rive is admirably adapted for *small* pictures where great gloss is requisite.

Saxe paper can be rendered nearly as glossy by doubly albumenizing and rolling.

Other papers generally give inferior tones to those above specified, though they are constantly employed.

Toning a Picture.—If a picture printed on albumenized paper or ordinary salted paper (see pages 113 and 115) were at once immersed in the fixing bath, the resulting colour of the image would be of a disagreeable foxy red. In order to remedy this, it is usual to tone the picture by means of a solution of gold.

Supposing a print to be thoroughly washed, and immersed in a dilute solution of gold terchloride, the following phenomena would present themselves: the picture would gradually bleach, and a blue deposit would take the place of the more vigorous red image, and on immersion in the fixing bath it would be of a most feeble character. The reason of these changes is this: the chlorine from the gold would attack the silver subchloride, and while depositing as a metal, would in reality convert the image back to the state of chloride; owing to one atom of gold combining with three atoms of chlorine, the deposited metal would

be much less than if the subchloride had been split up into metallic silver and chloride by the fixing bath. Thus :—

Silver Sub-chloride. Gold Chloride. Silver Chloride. Gold.

$$3\,Ag_2\,Cl + Au\,Cl_3 = 6\,Ag\,Cl + Au$$

In the second case we should have—

Silver Chloride dissolved. Silver left to form the print.

$$3\,Ag_2\,Cl = 3\,Ag\,Cl + 3\,Ag$$

In order to avoid loss of vigour, it is usual to add some compound to the gold solution, and in certain cases to leave a small quantity of silver nitrate in the paper. When free silver nitrate is thus present, the compound added to the gold should be a retarder in its action, that when the free nitrate of silver is wholly washed out the compound should be an active absorbent of chlorine.

As an example of the first case, suppose the lime bath is used (see page 120), where we have a mixture of calcium hypochlorite and calcium chloride ; the latter acts as a retarder to the deposit of the gold, as the chlorine from each of these is nearly equally attracted to the silver nitrate. Hence the addition of chloride of lime naturally checks the too rapid deposition of the gold, and the consequent attack on the silver sub-chloride.

As an example of the last case, where all the free nitrate of silver is washed out : sodium acetate has more affinity for chlorine than has the silver subchloride ; hence there is but slight reduction in the depth of the print in fixing.

It has been assumed that the additions to the toning bath cause the formation of an oxy-chloride of gold. This may be the case, though the argument seems somewhat obscure. A simple experiment with stannous chloride added to the gold solution will give proof that the absorption of chlorine alone is necessary.

Fixing the Print.—Sodium hyposulphite is almost invariably used as the fixing agent, and a strong solution is necessary to secure permanency of the print. The reason is that there are two silver hyposulphites which can be formed :—

Silver Chloride. Sodium Hyposulphite. Double Hyposulphite of Silver and Sodium. Sodium Chloride.

$$Ag\,Cl + Na_2\,S_2\,O_3 = Ag\,Na\,S_2\,O_3 + Na\,Cl$$

and

Silver Chloride. Sodium Hyposulphite. Hyposulphite of Sodium and Silver. Sodium Chloride.

$$2\,Ag\,Cl + 3\,Na_2\,S_2\,O_3 = Ag_2\,Na_4\,3(S_2\,O_3) + 2\,Na\,Cl$$

The first double hyposulphite is nearly insoluble in water; the last is highly soluble. These two salts may be formed for experiment, in the first case by adding an excess of silver nitrate to the sodium hyposulphite solution, in the other by adding a large excess of the latter to the former. With the first we have a dirty-brown precipitate; with the latter there will be a perfectly clear solution. The student is recommended to try the experiment.

MANIPULATIONS IN SILVER PRINTING.

Albumenizing Paper.—The following is a useful formula for albumenizing paper:—

Ammonium chloride	100 to 200 grains
Spirits of wine	½ ounce
Water	4½ ounces

When these are thoroughly dissolved, fifteen ounces of albumen* should be added. These ingredients then should be beaten up with a bundle of quills or a swizzle-stick. Constant shaking for half an hour in a bottle (holding about double the quantity of mixture prepared) will answer instead.

Having allowed the deposit in the albumen to settle, it is filtered through a sponge placed in a funnel, and from thence poured into a porcelain or other flat dish. The paper being cut into sheets of convenient size, the opposite corners of a sheet, the smooth side underneath, are then taken up by the manipulator (one in each hand), and a convex surface is given to it by nearly bringing the two hands together. The middle of the paper first touches the albumen solution, and the corners held by the hand are gradually brought down till the sheet floats on the liquid. The formation of air-bubbles on the surface of the paper is thus prevented, as they are squeezed out. The sheet should remain upon the solution a little over a minute, and should then be raised very gradually off by one corner, and hung up by two corners to dry. Two American clips answer for holding the paper whilst drying. Should bubbles be apparent, the paper must be floated again, till a uniform surface is secured.

When dried, the prepared paper should be rolled and put way flat.

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* The eggs used must be nearly fresh. Each good sized English egg will furnish one ounce, whilst an Indian one will only yield five-eighths of an ounce on an average.

Should the paper be floated much longer than stated above, the albumen, being prepared with an alkaline salt, is apt to dissolve the size and sink into the paper. This would destroy the gloss

PLAIN SALTED PAPER.

Prints on plain paper are useful in certain instances. The formula for preparation is given :—

Ammonium chloride	60 to 80 grains
Sodium citrate	100 ,,
Sodium chloride	20 to 30 ,,
Gelatine	10 ,,
Distilled water	10 ounces
Or,	
Ammonium chloride	100 grains
Gelatine	10 ,,
Water	10 ounces

The gelatine is first dissolved in hot water, and the remaining components of the formulæ are added. It is then filtered, and the paper is floated for three minutes, as in directions for Albumenizing Paper. If it be required to print on plain paper in a hurry, a wash of citric acid and water (one grain to the ounce) may be brushed over the back of ordinary albumenized paper, and, when dried, that side of the paper may be sensitized and printed in the ordinary manner. For cold tones the wash of the citric acid may be omitted. Resinized paper, which can be supplied by various manufacturers, may also be found useful for corners of maps and engravings.

If the baths be new, and no injurious vapours be present in the air, sensitized paper will keep from a couple of days in hot weather to a week in cold.

THE SENSITIZING BATH.

A good standard for a sensitizing bath is as follows :—

Silver nitrate	50 grains
Distilled water	1 ounce

This solution is suitable for most albumenized paper of commerce that is in the market when it is required to print from

good negatives of a fair density. The paper is floated on the sensitizing solution from about three minutes in hot weather to five in cold. The method of floating is similar to that given above for floating on the albumen solution.

Care should also be taken to withdraw the paper slowly, as the capillary attraction will remove nearly all excess of silver solution, and thus prevent a waste by the droppings, and a loss of time in drying. The paper should be hung up from one corner by an American clip, and a small piece of clean blotting-paper should be attached to the bottom corner to collect the excess of solution. This blotting-paper should afterwards be placed with the paper residues.

The sensitizing solution will, after a few sheets are floated, be found to be below strength. It should be tested by the argentometer (which indicates the number of grains on its stem), or by the method given in the Appendix. The argentometer is somewhat uncertain, as it also indicates the amount of albumen and salts dissolved in the solution. It is, however, sufficiently correct for ordinary use.

The sensitizing solution, after a day or two, will be found to become discoloured, owing to the albumen dissolved in the liquid. The method of freeing the solution from it is given in the Appendix.

When the albumenized paper is very nearly dry, but not so much so as to crack on unrolling it when it is removed from the clip, it should be placed in clean blotting-paper between boards, in order to be flattened for printing.

Should a negative be found very hard, a slight modification of the sensitizing solution will be found beneficial, supposing the ordinary paper is to be used.

Silver nitrate	30 grains
Water	1 ounce

The negative should in this case be printed in the sun. The more intense the light, the less contrast there will be in the print, as the stronger light more rapidly effects a change in the albumenate than if subjected to weaker diffused light. The reason for the reduction in quantity of the silver nitrate in the solution is given on page 109.

To print from a weak negative, the sensitizing solution should be :—

Silver nitrate	80 grains
Water	1 ounce

The printing should take place in the shade; the weaker the negative, the more diffused the light should be.

If a negative be dense, but all the gradations of light and shade be perfect, the strong bath, and, if possible, a strongly-salted paper, should be used. The printing should take place in sunlight.

It may happen that with a very weak sensitizing solution the albumen may have a tendency to dissolve from off the paper; the addition of ten to twenty grains of sodium nitrate, or a drachm of alcohol, to the ounce, will prevent the evil recurring.

WASHED SENSITIVE PAPER.

A method of keeping it for longer periods (say for a week or a fortnight) without discolouring has been introduced. It is more sensitive, tones more rapidly, and gives more uniform results than the ordinary sensitized paper; still the negatives may be more than ordinarily weak, and good prints be obtained.

The paper, sensitized as usual, is passed, not soaked, face downwards, through two or three changes of water,* and hung up to dry. The pads of the pressure frame must be fumed with ammonia previous to using the washed paper, in order to produce a rich print—the reason, apparently, being that an alkaline salt of silver is formed on the surface of the paper, which replaces, as it were, the silver nitrate. The alkaline salt seems to be a better sensitizer than the acid or neutral silver salt. Colonel Stuart Wortley's plan seems the best method of impregnating them with ammonia. He places all the pads to be used in a large box overnight, with a little strong ammonia in a saucer at the bottom of the box; by the morning they are sufficiently fumed.

The sensitizing bath should not be acid. If a small quantity of silver carbonate† remain at the bottom of the bottle holding the stock solution, the acidity is prevented. A little powdered chalk added to the bottle answers equally well.

Colonel Stuart Wortley uses the following bath for sensitizing paper that is to be washed:—

Silver nitrate	35 grains
Lead nitrate	13 ,,
Sugar	2 ,,
Water	1 ounce

* All the free silver nitrate must not be washed away, otherwise the print will want in depth of tone.

† The addition of sodium carbonate will form the carbonate of silver.

The washed paper may be stored between clean and dry blotting-paper, and pressed between two flat boards. The less air admitted to it the longer it will keep.

DURABLE SENSITIZED PAPERS.

In the market there are two or three permanent sensitized papers, Durand's being the best known. They are printed, toned, and fixed in the usual manner. There is sometimes a slight lack of vigour in the resulting prints, however, which is partially overcome by fuming the pads as described above.

Mr. Hopkins has adopted a method of preserving sensitive paper. He floats the sheets of albumenized paper on a 40-grain bath, as usual; then dries till nearly all the moisture is gone. He then places them between sheets of blotting-paper previously impregnated with sodium carbonate solution (about thirty grains to the ounce of water) and allowed to desiccate. The pile of paper he places under pressure, and withdraws the sheets as required.

Another plan of keeping paper in a sensitive condition is by adding from twenty to forty grains of citric acid to each ounce of nitrate of silver solution. Many find this to give good results, whilst others find a lack of vigour after toning.

PRINTING THE PICTURE.

Skill is required for obtaining the most perfect prints from any negative, and it is only by paying attention to trifling details that such happy results can be obtained. It should be remembered that no blind adherence to any rules will attain the object in view; printing requires thought to be exercised, as well as clean manipulation.

In the foregoing article several hints as to the light that should be used for different qualities of negatives have been given, but a little extra trouble bestowed may add to the beauty of the picture.

Should a picture print too black in the shadows—*i.e.*, attain a bronze colour—before the details in the lights have printed in, much improvement will be discerned by shading these dark portions. This shading may be done either by placing temporarily a paper, whilst printing, or gumming tissue paper, cut to the proper shape, on the reverse side of the negative. On the deepest shadows two or more layers of tissue paper may be gummed, till the desired effect has been attained. In some cases cotton-wool

may be placed over a defective spot which prints in too quickly; and, in extreme cases, where high lights are wanted, a skilful touch of the brush (using Indian ink or sepia) on the film side will give a piquancy to the print which would not be otherwise obtained.

In landscapes there is frequently a want of atmosphere in the far distance and middle distance. In order to give it, the whole of the back of the negative should be covered over with tissue paper by means of starch, and when dry the shadows in the distance should be made less obtrusive by means of a stump and powdered crayon. The foreground may be caused to approach by heightening its high lights. A golden rule to remember is, that the greater the distance of an object, the greyer the high lights, and less heavy the shadows.

The sky in some negatives prints in too deeply: a mask, cut to the outline of the landscape, and slightly raised from the surface of the negative, will give a graduated sky, which, if left too white, may be subsequently improved by "sunning" down. This sunning down is generally carried out by means of a sheet of non-actinic paper or cardboard. This is moved gently over the picture, leaving the upper portion of sky more exposed to the action of the light than the lower portion, the landscape itself being always completely covered up.

In many landscapes some secondary object, by the brilliancy of its high lights, may attract the eye. As the object of all artistic photography is to cause the eye primarily to dwell on the most important point, these bright spots, if they interfere with the effect of the picture, should be sunned down by shading all the print except that particular part. This may be secured by using a brown paper mask, cutting out the shape of the object to be toned down. For this object the negative should be removed, and a clean piece of glass substituted for it in the printing-frame.

Transparent spots in the negative may be touched out on the negative itself. Gum should not be mixed with the paint used, for reasons given at page 41. Opaque spots in the negative print white in the print, and these can only be touched out on the print after it is fixed and dried.

In toning operations the print loses depth, varying in a great measure according to the toning bath used. This loss of depth should be allowed for in the printing, the picture when taken out of the frame being considerably darker than when finished.

To judge the proper depth of colour to be given is, perhaps, one of the most difficult things in photography. Practice alone can determine when a print should be withdrawn from the frame.

After the negative has been placed with the film side towards the back of the frame, a piece of paper the size of the plate should be placed on it. A felt or flannel pad should next cover the paper, and the back be placed over this.

The pad is principally used to cause an equal pressure being exerted between the negative and the paper. Should the pressure be unequal, the paper will be found not to be in contact at places, and there will be a fuzzy appearance at those parts of the print. Even when pads are used, it is not unfrequently the case that this want of contact exists. If the paper have been dried in a moister, hotter, drier, or cooler atmosphere than that in which the printing takes place, this defect may ensue. In such cases it is a good plan to let the paper remain in the printing room half an hour before the printing commences, and to place the sheet of paper on the negative in the frame, with the pad behind it, not pressing down the springs on the back. The negative, of course, should be face downwards on the floor to prevent the passage of light through it. After five minutes or so the paper will become contracted or expanded sufficiently to enable complete contact to be maintained.

A great source of defective prints is their examination during printing. The frame should never be opened in bright light, otherwise the whole exposed surface of the print may become discoloured, and the purity of the whites lost.

When prints are removed from the frames, they should be stored in a dark box, or between leaves of red blotting-paper in a large book.

TONING THE PICTURE.

The following toning baths are found to give good results. No 1 is found to be very stable, and to give brilliant tones :—

No. 1.—Gold tri-chloride	... ...	2 grains
Chlorinetted lime (chloride of lime)		2 ,,
Chalk	... ...	1 teaspoonful
Water	... ...	16 ounces

If the water be hot, the bath may be used when cool ; if not a day should elapse between mixing and using it.

No. 2.—Sodium acetate	... ...	30 grains
Gold tri-chloride	... ...	1 grain
Water	... ...	10 ounces

To be mixed the day before it is used.

No. 3.—Chloride of lime	... ...	45 grains
Gold tri-chloride	... ...	45 ,,
Chalk	... ...	45 ,,
Sodium acetate	... ...	180 ,,
Water	... ...	15 ounces

(These to be mixed together, without filtering, from seven to fourteen days before use. When required to use, filter out one ounce of solution, and add to eleven ounces of water.)

No. 4.—Gold tri-chloride	... ...	1 grain
Sodium carbonate	... ...	10 grains
Water	... ...	1 ounce

May be used immediately.

Other toning baths have been employed, but the foregoing are the principal used with albumenized paper.

Nos. 1, 2, and 3 will keep indefinitely. When the bath becomes inactive from lack of gold, it may be strengthened by a solution containing only one ounce of water to the above quantities of the other ingredients. No. 4 can only be used on the day it is made.

According to the minuteness of the grains of gold, so will it assume, by reflected light, colours varying from purple to that of the ordinary yellow. The organo-chloride of silver appears through this layer of gold, and the colours of the two mingling together give the different tones in ordinary prints. When a print is over-toned it becomes blue. This is due to the greater amount of gold deposited over the surface of the silver. The change in colour on the immersion of a print in the fixing bath is due to the solubility of the silver chloride.

With all the toning baths, excepting No. 3, a little of the free silver nitrate should be allowed to remain in the print—that is, before being immersed in the toning bath, the prints should not be too thoroughly washed (see page 111); whilst with the acetate bath it can be shown that all the soluble silver salt should be got rid of. In the first case, the prints should be washed in two changes of water, and the last change should show

decided milkiness.* The paper is immersed in the water, albumenized face downwards, to prevent the silver chloride or carbonate (that may be formed from the chlorides or carbonates in the water with the free silver nitrate) being precipitated on the surface of the print, and the gold being deposited on it. Should there be a deposit on the print, it is dissolved away by the fixing bath, and leaves minute spots untoned.

The toning bath should be sufficiently large to contain a couple of the largest prints side by side. No more should be immersed in it than can be conveniently turned over without risk; eight or nine medium-sized prints are generally found sufficient. The bath should be given a continuous and gentle rocking motion, allowing the solution to flow over and between all the prints immersed. This prevents any two prints sticking together, and the consequent want of tone on those parts which have been in contact. The print must be toned a little further than it is intended to remain; for black tones a slight blueness must be perceptible. In all cases, however, it should possess a rich colour before fixing. It is a good plan to allow the prints to tone face downwards, all deposit of silver chloride formed from the free silver nitrate being by this means kept from their faces.

FIXING THE PRINT.

The usual strength of the fixing bath is—

Sodium hyposulphite	4 ounces†
Water	1 pint

Between toning and fixing it is well to wash the prints slightly. After taking them out of the toning bath they should be placed in a dish of water, face downwards, till a bath is ready for fixing.

It will be noticed that the toning action on the print continues during this washing, presumably by the solution of gold contained in the pores of the paper continuing to deposit. The addition of a small quantity of common salt has been found useful to stop this action. If this precaution be not taken, the prints first toned should be left redder than it is intended they should

* The milkiness is only perceptible when the water contains chlorides or carbonates.

† One ounce of sodium hyposulphite will fix *with safety three sheets of paper.*

remain. The action can also be arrested by acidifying the water. This is dangerous, as the presence of acid in the fixing bath causes a speedy decomposition of the hyposulphite.

The prints should be immersed in the fixing bath for twelve or fifteen minutes.* The solution should be kept in motion during the whole time of fixing, as for toning. Care should be taken to brush off all bubbles that may cling to their surfaces, as the cushion of air impedes the access of the liquid to the silver salt.

When the prints are fixed they will appear colourless in the whites, and free from red patches in the dark portions.

In some establishments it has been found advantageous to add a drachm of ammonia to each pint of fixing solution. The ammonia aids the rapidity of fixing, and neutralizes any acid that inadvertently may find its way into the solution; it also attacks the size of the paper, dissolving it out from the paper in a great measure. This renders the washing more perfect, and is found to prevent "blistering," which is common with so many albumenized papers.

The prints should be withdrawn slowly from the bath—in order that all excess of the hyposulphite solution may be drawn from them by capillary attraction—and placed in a trough of water, where they should soak a quarter of an hour. They should then be removed, as before, and placed in a stream of running water for twelve hours. If running water be not attainable, a good plan is to place the prints in a dish, changing the water every half hour for five or six changes, and sponging all the moisture out as far as possible after every second change. By this procedure the hyposulphite is almost totally eliminated. Prints washed in this manner have remained unaltered in colour for the last twelve years in the writer's experience, having passed through climates dry and moist, and varying in temperature from 20° to 110°.

It is useful sometimes to test the water for sodium hyposulphite soda after the last washing, in order to ascertain if its extraction be complete. The following is a most delicate test.

Make the following test solution:—

Potassium permanganate	...	...	2 grains
Potassium carbonate	...	...	20 ,,
Water	...	...	1 quart

* The thicker the paper the longer the time of immersion.

The addition of a few drops of this rose-coloured solution to a pint of water will yield a slightly pink tinge. If there be any trace of sodium hyposulphite present, the colour will be of a greenish hue.

If the permanganate be not at hand, the following well-known starch iodide test may be adopted :—

Take about two drachms of water and a small piece of starch about the size of a small pea, powder and boil the starch in the water till the solution is quite clear; add one drop of a saturated solution of iodine in alcohol to this clear liquid. It will now become dark blue. Of this solution drop two drops into two clean test tubes, and fill up one with distilled water and the other with the water to be tested; a faint blue colour should be perceptible in the first test tube. In the second test tube, should hyposulphite be present, this blue colour will have disappeared, the iodide of starch becoming colourless in its presence. The best mode of comparing the two waters is by placing a piece of white paper behind the test tubes.

It frequently occurs that though sodium hyposulphite cannot be detected in the washing water, it may be present in the paper itself. The paper on which most prints are taken being sized with starch, if a *very* weak solution of iodine be applied with a brush across the *back* of a print, a blue mark will indicate the *absence* of the hyposulphite. Care must be taken that the iodine solution is *very* weak, otherwise a part of the iodine will first destroy the trace of the salt, and then the remainder will bring out the blue re-action.

The dishes used for *toning, sensitizing, and fixing should be used for no other purpose* than that to which they are originally allotted. A porcelain dish on which the glaze has cracked should be rejected for the sensitizing dish and for the fixing dish. In the first case, the porous porcelain absorbs a vast quantity of silver nitrate; and in the latter, old sodium hyposulphite, when it is *very* apt to cause yellow markings on the prints.

Tin dishes should be avoided in all cases. The tin corrodes and marks the pictures. Perforated zinc is often used for the bottoms of washing troughs. This also should be avoided, as after a time it becomes fouled, the sodium hyposulphite acting upon it, and the prints get stained where they touch it.

DEFECTS IN PRINTS.

Small white spots, with a black central pin-point, are often met with in prints. Dust on the paper during sensitizing will cause them, the grit forming a nucleus for a minute bubble. All paper should be thoroughly dusted before being floated on the sensitizing bath.

Grey, star-like spots arise from small particles of inorganic matter, such as ferric oxide, lime, &c., which are present in the paper. They become more apparent by decomposition during the printing operations. They may generally be discernible by examining the paper by transmitted light.

Bronzed lines (straight) occur through a stoppage during floating the paper in the sensitizing solution. Should the lines be irregular, forming angles and curves, it is probable that a scum of silver oxide, &c., may be detected on the surface of the sensitizing solution. A strip of blotting-paper drawn across the bath will remove the cause of the defect.

Should the print appear marbled, it may be surmised that the sensitizing solution is weak, or that the paper has not been floated long enough. In some cases it may arise from imperfect albumenizing; but in ordinary commercial samples the cause can be easily traced.

Red marks on the shadows may appear during toning, and are very conspicuous after fixing. They generally arise from handling the paper with hot, moist fingers after sensitizing; grease, being deposited on the surface, prevents the toning bath acting properly on such parts.

Weak prints are generally caused by weak negatives. Such can be partially remedied by paying attention to the strength of the sensitizing bath (as shown in page 109), and by using washed paper.

Harsh prints are due to harsh negatives. They can generally be remedied by paying attention to the mode of printing, also given at page 118. If the negative be under-exposed and wanting in detail, there is, however, no cure for this defect.

A red tone is due to insufficient toning; whilst a poor and blue tone is due to an excess of toning.

The whites may appear yellow from imperfect washing, imperfect toning, or imperfect fixing.

Should prints refuse to tone, either the gold has been exhausted, or else a trace of sodium hyposulphite has been carried

into the toning bath by the fingers or other means. A trace of hyposulphite is much more injurious to the print than a fair quantity of it. Should the toning bath refuse to tone after the addition of gold, it may be presumed that it is contaminated by a trace of sodium hyposulphite.

A dark mottled appearance in the body of the paper indicates imperfect fixing, combined with the action of the light on the unaltered chloride during fixing. If the fixing bath be acid, the excess of acid combines with the sulphur, and forms hydrosulphuric acid, which will also cause the defect.

The cause of mealiness or "measles" in the print has been explained in page 111.

Maxims for Printing.

1. The print should have the highest lights *nearly* white, and the shadows verging on a bronzed colour before toning.

2. Place the prints, before toning, in the water, face downwards, and do not wash away too much of the free nitrate of silver (see exception, page 111).

3. The toning solution must be neutral or slightly alkaline, and not colder than 60°.

4. Tone the prints to purple or sepia, according as warm or brown prints are required.

5. Move the prints, in both the toning and fixing solutions, repeatedly, taking care that no air-bubbles form on the surface.

6. Take care that the fixing bath is not acid.

7. Use fresh sodium hyposulphite solution for each batch of prints to be fixed.

8. Wash thoroughly after and before fixing.

9. Make a sensitizing bath of a strength likely to give the best results with the negatives to be printed.

10. Print in the shade, or direct sunshine, according to the density of the negative.

COLLODIO-CHLORIDE PAPER.

The collodio-chloride process was introduced by Mr. G. Wharton Simpson, the Editor of the PHOTOGRAPHIC NEWS. Primarily, it was introduced for printing on glass or paper, and for such it is given here.

The collodio-chloride is formed as follows :—

*No. 1—Silver nitrate...	...	...	...	1 drachm
Distilled water	...	...	...	1 ,,
No. 2—Strontium chloride	...	...	...	64 grains
Alcohol	...	...	...	2 ounces
No. 3—Citric acid	...	...	...	64 grains
Alcohol	...	...	...	2 ounces

To every two ounces of plain collodion add thirty drops of No. 1, previously mixed with one drachm of alcohol; then add one drachm of No. 2, shaking well at the same time; lastly, half a drachm of No. 3 solution. In a quarter of an hour it is fit for use. There is sometimes a difficulty found (especially when applying the collodio-chloride to glass) due to the crystallization of the salts on the surface of the film. The writer has entirely overcome it by using the above proportions, and then washing the emulsion thus formed in a similar manner as directed for the bromide emulsion (see page 82). It is, however, necessary to add a small quantity of silver nitrate, after re-dissolving the collodion pellicle in the proper proportion of solvents; about eight grains to the ounce of emulsion is the amount recommended.

The above formulæ apply to printing on paper, or on glass, porcelain, &c.

The paper best adapted for the reception of the collodio-chloride is arrowroot paper. A paper rather larger than the size of print required is taken, the edges turned up for one-eighth of an inch all round to form a tray, leaving a small spout at one corner. This paper is then pinned on to a board by the four corners, and is coated in a dark-room with the collodion as for the collodio-bromide process. When well dried, it may be found to increase the brilliancy of the resulting print by pinning it on the inside of the lid of a large box, and exposing it to the fumes of a drachm of ammonia poured into a saucer.

The print is taken in the ordinary manner, and may be toned by any of the ordinary toning baths, the lime bath (No. 1, page 119) being the best, providing it be old.

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* The formulæ are taken from the YEAR-BOOK OF PHOTOGRAPHY for 1871.

The following toning bath, made in two separate solutions, gives rather inky tones :—

No. 1.—Ammonium sulphocyanide ...	1¼	ounces
Sodium hyposulphite ...	45	grains
Sodium carbonate	15	,,
Water	50	ounces
No. 2.—Gold trichloride	30	grains
Chalk	1	teaspoonful
Water	50	ounces

Equal quantities of these are taken and mixed, and the toning proceeds as usual. The prints ordinarily take from two to ten minutes to tone. If a longer time be required, add more gold till the desired effect is produced. This toning bath can only be used once.

FIXING BATH.

The fixing bath is composed as follows :—

Sodium hyposulphite	1 ounce
Water	30 ounces

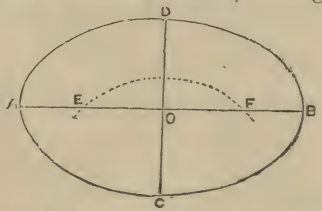
The print should be immersed in this about eight minutes.

MOUNTING PRINTS.

More care than is usually bestowed is necessary to mount prints, whether produced by the silver printing, or the permanent pigment processes. When silver prints are taken from the drying line they are found to be rolled up, and slightly cockled, it may be, in parts; in this state it is difficult to mount them. The method of *stroking* prints has been introduced to get rid of these defects. A flat piece of hard wood, about one foot long and one and a-half inch broad, and the thickness of a marquoise scale, has its edges carefully rounded off. The print is seized by one corner in one hand, and unrolled; the face of the print is brought in contact with a piece of plate-glass. The "stroker," held by the other hand, is brought with its rounded edge on to the back of the print near the corner held by the first hand. Considerable pressure is brought upon the stroker, and the print is drawn through between it and the plate. The print is then seized by another corner and similarly treated. By this means a gloss is put upon the print, and the creases and cockles are obliterated. The print is now ready for cutting out.

It is well to have a square of glass with true edges cut to the size of the pictures generally taken. The prints should be trimmed upon a sheet of plate glass, a sharp penknife being used to cut them. A rough test for ascertaining if the opposite sides are equal is to bring them together and see if both corners coincide.

It may sometimes be found useful to cut out a print into an oval. The following method for tracing any ellipse may be employed:—On a thickish piece of clean paper draw a line AB, making it the *extreme* width of the oval required. Bisect it at O, and draw DOC at right angles to AB. Make OC equal to *half* the smallest diameter of the ellipse. With the centre C and the distance CD draw an arc of a circle, cutting AB in E and F.



Place the paper on a flat board, and at E and F fix two drawing pins. Take a piece of thread and double it, knotting it together in such a manner that its length when doubled is equal to AB. Place the thread round the two pins at E and F, and stretch it out to tightness by the point of a lead pencil. Move the pencil guided by the cotton, taking care to keep it upright. The resulting figure will be an ellipse. Modifications of this figure may be made by making a second knot beyond the first knot, and placing the point of the pencil in the loop formed. When the figure has been traced in pencil on the paper, it should be carefully cut out with a sharp penknife, and placed on the print which is to be trimmed into an oval. When so placed, a faint pencil line is run round on the print, and the cutting out proceeds either by scissors or penknife. Ovals, in sheet tin or brass of different sizes, are supplied by the dealers in photographic apparatus. The little instrument called the photographic

trimmer is excessively handy for cutting out the prints when

such have been procured. The cutting-wheel is brought against the edge of the shape, and, being pivotted, follows the curve mechanically.

There are a variety of mounting solutions in common use, the most favourite being starch. This is prepared in the ordinary way, and is laid on the back of the print by a hog's-bristle brush. Starch is dangerous to use, unless perfectly pure and fresh. It is apt to liberate an acid, which destroys a print in contact with it.

To prepare gelatine for mounting, take half a wineglassful of gelatine, and cover it with cold water; when thoroughly swelled—which will be in about three-quarters of an hour—pour off any water that has not been absorbed, and fill up the wine-glass with boiling water. The gelatine will now be dissolved, and will remain fluid if the wine-glass be kept standing in warm water. This mounting medium is applied in the same way as the starch. Very thin glue is also occasionally employed, and answers well. In the market, at the present time, there are two or three made-up mounting solutions. "Marion's Mounting Medium"* answers admirably for small pictures, though when prints of 15 by 12 are to be mounted, it is apt to be rather difficult to give the back an even coating before it dries.

One great advantage of this solution is that it does not cockle the mount, however thin it may be. Prints may be mounted on foolscap paper with the greatest ease, and they will be as flat as if mounted on the thickest cardboard. A similar solution, suggested by Mr. G. Wharton Simpson, is made as follows:—Take gelatine or fine shreds of glue, and swell them with the least possible quantity of water. Boil them with alcohol, keeping them in agitation with a stirring rod the whole time. Eighty grains of gelatine will take about two ounces of alcohol to render it of a fit consistency for mounting. When cool the solution will become gelatinous. It can be used for mounting by letting it stand in a pot of warm water.

Before applying the mounting solution, the places where the corners of the print will come on the card should be marked with fine dots. The back of the print, having then been brushed over with the mounting solution, should be carefully placed on the mount, the corners coinciding with the dots. A piece of white

* To be obtained from Messrs. Marion, Soho Square.

blotting-paper should next be placed over the print, and the back of the print should be brought in close contact with the mount by rubbing the clenched hand over the blotting-paper. To obtain great evenness a piece of white cream-laid paper may then be placed over the print, and the edge of an ivory (or other smooth substance) paper-knife be scraped briskly over it. This adds a brilliancy to the print, and prevents cockling in a great measure when starch or gelatine is used, all excess being squeezed out.

The print is ready for rolling after the mounting solution is well dried. Finally, the surface of the mounted print may be waxed. There are various formulæ for the encaustic, the simplest being :—

White wax	1 ounce
Spirits of turpentine	1 ,,

the solution taking plainly by the aid of heat.

Mr. Valentine Blanchard uses white wax dissolved in benzole. This, he states, leaves a good coating of wax on the print, the benzole evaporating entirely.

M. Adam-Salomon's encaustic paste is made as follows :—

Pure virgin wax	500 grains
Gum elemi	10 ,,
Benzole	½ ounce
Essence of lavender	¾ ,,
Oil of spike...	1 drachm

The waxing solution may be taken up by a tuft of cotton wool, and spread roughly over the surface of the print. A clean pad of cotton wool is then used to rub it well in, till the surface assumes a bright gloss, and is free from all appearance of markings. For increasing the depth of shadow and general beauty of a print, waxing is of the greatest utility.

Recently burnishers of a very excellent type have been introduced into the market. Burnishing gives extraordinary brilliancy to a print, and is easily executed with a proper instrument.

PRINTS OBTAINED BY THE AID OF CHROMIC ACID COMPOUNDS.

If gelatine be mixed with a solution of a dichromatic of an alkali, and dried in non-actinic light, it will be found that it is perfectly soluble in water. If, however, it be exposed to the action of light, it will be found to have become insoluble. On this rests the whole superstructure of permanent pigment printing, photo-lithography, heliotypy, papyrotypy, and such processes akin to them.

The chemistry of the process is rather involved in difficulties, on account of the organic changes that may take place in the gelatine. It will suffice to point out the main action that takes place, viz., that "gelatine, aided by light, reduces the chromic acid of the bichromate to a lower state of oxidation, and then enters into combination with a compound of chromic oxide produced by the mutual decomposition of the chromic acid and gelatine, the original being the formation of a leather-like substance,"* insoluble in hot water. The addition of various substances to the gelatinous compound has been found to aid this decomposition.

THE AUTOTYPE PROCESS.

The first process that is to be described is known as the "Autotype."

From the Autotype Company can be procured sheets and rolls of coloured gelatinized paper of every tint, and these are the foundation of all their permanent prints.

The carbon tissue, as it is termed, is difficult to prepare on a small scale; hence it is better to procure it direct from the firm above indicated. They supply it ready sensitized, and it can be transmitted by post; otherwise it is necessary to float it on a solution of bichromate of potash and water—

Pure potassium dichromate	1 ounce
Water	20 ounces

The potassium dichromate should be nearly neutral, and

* From a paper read before the Photographic Society, May 10th, 1870 Mr. Swan.

contain no free acid. Should it contain acid, the tissue is liable to become insoluble. Free acid* may be neutralized by the addition of potash in solution till no extraordinary acid reaction is evident to blue litmus paper. A dish somewhat larger than the paper to be floated is used for floating. The solution should be at least a quarter of an inch in depth in the dish. The piece of pigmented paper is taken, and a quarter of an inch folded back at one end at right angles, and rolled up to a diameter of about two to three inches, gelatine surface outside. The turned-up end remains on the outside of the roll. The angle of the folded end is now dropped upon the solution, and the coil of paper is allowed to unfold itself, driving out all bubbles behind as its surface comes in contact with the solution.

The floating should last from two minutes in warm weather to three in cold.† The turned-up end should then be pinned by a couple of pins on a thin lath, and slowly withdrawn from the bath, and hung up to dry.

The drying of the tissue should take place in a room perfectly free from vapours, such as sulphuretted hydrogen, or those produced by the combustion of gas. If possible, a current of warm, dry air should be created through the drying room; in summer a large candle placed in a chimney will create sufficient draught, if the paper be dried near the fireplace. The quicker the paper dries, the better will it work, though the less sensitive it is to light.

When quite dry, the paper is exposed under the negative in the ordinary manner, a "safe edge," as it is technically termed, being placed round it. The safe edge consists of a mask of brown or other non-actinic paper, externally larger than the negative, and internally slightly smaller, the negative being, as it were, framed by it. The pigmented paper must be slightly larger (say half an inch each way) than the size of the print required. If the print be examined during exposure, there will be no change in its appearance, owing to the pigments used to give it the necessary colour; consequently it is necessary to use an actinometer to time the exposure.

The autotype actinometer consists of a slip of albumenized

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* Potassium dichromate always shows a slightly acid reaction to test-paper.

† Should the temperature of the solution exceed 80° F., it must be reduced by adding a little pounded ice.

paper,* rendered sensitive by a standard silver solution. This becomes tinted or coloured by exposure to the light. The tint thus produced is compared with a standard one, *painted* on a strip of paper or tin. When about to be used, a small portion of the strip of paper is exposed to the light simultaneously with the print. When the paper has attained the colour of the painted standard, it is said to have had one tint. A fresh piece of paper is then exposed for another tint, and so on.

For a negative of ordinary density two tints will generally be found sufficient in summer, and probably five in winter, but experience must decide the time required for different negatives. Some five years ago, however, it came to the writer's notice that the length of exposure to actinic light necessary to produce a print by the autotype carbon process might be diminished by three-quarters, or even seven-eighths, by withdrawing the print from beneath the negative, and leaving it in the dark. The printing action started continued gradually, and finally, after a lapse of several hours, on development, the picture was found to be fully printed. In winter this curious continuating printing action was of special value, as it enabled eight times the number of prints to be produced from a negative by giving only an eighth of the right exposure, and then keeping them in a dark room. The writer also experimented with certain non-actinic lights, and found the same action was maintained, but with greater rapidity. Hence hanging a partially-exposed print up in a yellow lighted room was better than leaving it in the dark. When one quarter of the exposure was given, a print hung up in the dark was found to be properly printed in twelve hours; whilst if only one-eighth, it required sixteen hours. The development of the tissue should be conducted in a room in which the light is weak or non-actinic. Close at hand, on a table, should be a dish containing water to a depth of an inch or more. To the bottom of this is sunk a finely-mulled flat zinc plate, at least one inch larger each way than the negative; the paper is now drawn, face downwards, under the water, till it nearly rests upon the zinc plate. It will be noticed that the paper at first tends to coil downwards, but gradually unrols till it is perfectly flat, and if left it would coil upwards. At the moment it has become flat, the zinc plate is seized by the

* Other forms of actinometer are employed, which depend more on the principle of that employed for heliotypy (see page 145).

hands, and raised horizontally out from the dish, the tissue resting upon it. It is then placed on a small low stool standing in another dish; one end of the paper is next pressed on to the zinc plate by one hand, and with the other the remaining portions are brought into contact with the "squeegee."* The first portion of the tissue is then brought into contact with the zinc in the same manner.

The zinc plates used are termed the "temporary supports" of the tissue. They are mulled in the ordinary manner with a muller and fine sand; the finer the grain given, the finer in detail will be the resulting pictures. Care should be taken that no scratches are on them, as every scratch is reproduced in the finished print. It was found by Mr. Johnson, who introduced this method of transferring the prints, that it was necessary to coat the plates with a fatty and resinous substance, of sufficient tenacity to keep the prints on them during development, but which should have less adherence to them than the film of gelatine has to the paper with which it is to be backed or mounted.

The following is the composition of the fatty body :—

Beeswax	...	...	...	3 drachms
Yellow resin†	...	...	...	3 ,,
Oil of turpentine	...	...	...	1 pint

These proportions are not absolute, as the composition of the beeswax varies. The resin must be added to the beeswax to such an amount that the gelatine film will remain on the plate without cracking or peeling, even when dried in a hot room, but at the same time will leave the plate readily (when the applied transfer paper has become dried) without the application of any force.

With a piece of fine flannel, or cotton wool, a small quantity of the above fatty body should be rubbed on to the plate. With another piece the excess of grease must be polished off, leaving but a *minute* layer of the compound on the surface. The

* The squeegee consists of a flat piece of wood about two inches wide and three-sixteenths thick, into one edge of which is let a strip of india-rubber about half an inch wide, and projecting half that distance; the length of both the lath and india-rubber vary according to the size of the zinc plate. It is used by pressing the india-rubber edge against the paper, and passing it hastily over the surface.

† The resin causes the adherence of the film to the plate, whilst the beeswax diminishes that adherence to the limits above stated.

zinc plate is then ready for the transference to it of the tissue.

The zinc plates are cleaned, after being used, by rubbing with flannel in boiling water. If this be not sufficient, a little turpentine or ammonia will cleanse them thoroughly, and render them fit for a fresh application of the fatty compound.

For some purposes it may be deemed advisable to give the prints a more highly polished appearance than that furnished by the use of a grained zinc plate. A glass plate prepared as follows answers the purpose :—

Beeswax in shreds	...	...	...	60 grains
Methylated ether	...	...	...	20 ounces

After resting twenty-four hours the solution is decanted. To each part of clear fluid is then added five parts of benzoline. The plate is coated as with collodion, and dried. A coating of collodion is next given, and the surface thus prepared is used as a temporary support for the tissue.

Development is best effected by a trough or tin basin containing water, whose temperature can be maintained at 100° F. by aid of a gas jet or a spirit lamp. After the pigmented paper has been pressed into contact by the squeegee with the zinc plate, it should be laid aside for a couple of minutes, to allow the gelatine to swell. By the swelling of the gelatine a partial vacuum is created between it and the zinc plate, and the pressure of the air outside prevents it from peeling or stripping off. The zinc plate, with the adhering paper, is next placed horizontally in the trough for a minute, when it will be found that the paper can be peeled off, leaving the gelatine pigment on the zinc plate. The plate is now moved vertically in the water, or the water dashed over it with the hand; and gradually those parts of the gelatine which have been unacted upon by light will dissolve away, leaving the picture beautifully developed, with its half tones and deep shadows in perfect gradation. When the water flows from off the plate quite free of colouring matter it should be withdrawn, and then placed for a few seconds in alum and water (a dessert spoonful to a couple of gallons will suffice). This renders the remaining gelatine perfectly insoluble. Should a picture be only slightly under-exposed, plunging the plate into the alum water, at the stage required, will stop development and give a passable print. If a picture be slightly over-exposed, water heated to 130° will often

reduce its depth sufficiently. The plate, with the picture on it, should lastly be well washed under the tap to rid it of any traces of alum, and then set up in a rack to dry.

It may seem curious to some that the pigmented gelatine should have to be transferred from paper to zinc plates to be developed, or, in other words, that development takes place from the back of the gelatine. A little thought will clear up the mystery. The light acts on the pigment according to the actinism and *time* of exposure. A ray of light can only penetrate to do work to depths varying with its intensity (the variation is not a simple proportion, but much more complicated), and the amount of "work" done by it is in a ratio to the time of exposure.

The light passing through a negative at different parts varies in intensity. Thus it is evident that the insoluble part is at the surface, whilst the soluble is nearest the paper. Now, supposing it were attempted to develop the picture on the paper itself, it would be found that *nearly* all the *surface* of the pigment had become insoluble, and that, consequently, this leather-like substance would prevent the dissolution of the underneath portions, which were still soluble.

The best exposure for the paper is evidently when the light has penetrated in the deepest shadows just to the surface of the paper, whilst the densest parts of the negative have not allowed the passage of *any light*. It will be seen from this that a negative should possess similar good qualities as for silver printing.

The print on the zinc plate will be found to be reversed. This is as it should be, as in the re-transfer it will be found to be in its proper position. The transfer paper is coated with a preparation of insoluble gelatine. The re-transfer on to paper is effected in a similar manner to the transfer of the pigmented paper to the zinc. The paper is plunged into water of a temperature of about 170°, where it remains till it becomes slimy to the touch. The plate bearing the dried picture is now dipped into cold water, and carries as much as possible away with it in a horizontal position on to the stool already mentioned. The transfer paper is then placed, prepared side downwards, upon the cushion of water, and is "squeegeed" into close contact with the picture as before. It is then allowed to dry spontaneously (in the sun, if possible), after which it will be found readily to leave the plate, bearing with it the picture on its surface. If dried by the sun it will coil off the plate of its own accord. If the

paper be too hastily dried by the fire it will buckle and become cockled, and can only be flattened with difficulty.

If a matt surface be required, the print may be finished by rubbing with cotton-wool holding a little turpentine. A brilliant surface can be given by using an encaustic paste as for silver prints :—

White wax	...	...	...	1 ounce
Benzole	...	...	...	1 ,,

dissolved by the aid of heat;

Or—

White wax	...	...	...	1 ounce
Oil of turpentine	...	...	...	1 ,,

dissolved also by the aid of heat.

For printing portraits a glass plate may be used in lieu of the zinc. The surface should be rubbed over with the waxing compound. Great care is requisite that the resulting surface is free from lines, as it should be remembered that every line on the surface of the plate will be exactly reproduced in the print. The glass may also be coated with a film of plain collodion (which should be *perfectly* transparent when dry), and after varnishing round the edges the film may be used for the transfer. When re-transferred on to paper the collodion is detached, and the surface of the print is brilliantly glazed. It is advisable sometimes to rub the plate once, before applying the collodion, with a little white wax dissolved in ether. This facilitates the film leaving it. Mr. Johnson likewise coats the glass plate with water varnish, prepared as given for heliotypy.

Mr. Baden Pritchard re-transfers the picture *before* it has dried in the ordinary manner. He dries it after re-transferring by placing the zinc plate on a wide ring over a gas-burner. His observations led him to think that there is no deterioration in the print from this method. The danger to be apprehended is a separation of the film at the junction of the high lights with the shadows.

In practice (owing to indifferent gelatine being employed, or through other circumstances) occasional prints with cracks in the film, having an appearance of crape, are met with. These may often be remedied by placing the finished print in water of about 130° F., and leaving the gelatine to swell up once more. When dried, it will be found that the cracks have disappeared.

Mr. Sawyer, of the Autotype Company, has recently patented a flexible support, as a substitute for the zinc plate. It is made with a preparation of gelatine, and certain substances added to cause it to be insoluble and impermeable. The advantage claimed for it is that it expands with the tissue, eliminating the chance of a certain kind of blurring which has often been noticeable in the gelatine prints. The results obtained by its employment demonstrate the correctness of the claim. Another point in its favour is that the surface is less granular than with zinc, and the print is therefore more delicate.

The following is a description of the manufacture of the flexible support, taken from a paper read before the Photographic Society of Great Britain:—

"A solution of gelatine is made of variable strength, according to the quality of surface desired in the finished print. For a print to have a dead or matt surface, I employ about a five per cent. solution; for a more highly glazed surface, about seven and a-half per cent.; and for a surface equal to highly glazed albumenized paper, a ten per cent. solution. Paper wound on a reel, so as to be in a long length, is coated upon a carbon tissue-making machine with these solutions, and, when dry, is cut into sheets, and subjected to many tons' pressure in a hydraulic press. The solution of lac is made by dissolving one pound of button or bleached lac in five quarts of water in which have been dissolved four ounces of borax and one ounce of soda. This is put in what is called a digester, and heated until the lac is dissolved. The solution is then filtered, and when cold is ready for use. The gelatinized paper is floated on this solution in a shallow bath or tray, hung up to dry, and then finally rolled between metal plates in a rolling press. Each sheet is rubbed over with a little of a solution made by dissolving resin in turpentine, and adding thereto a few grains of wax."

SINGLE TRANSFER PRINTS.

There is another method of producing carbon prints without transferring them to zinc, viz., by transferring them direct to the paper on which they should finally rest. In order to employ this method it is necessary to obtain a reversed negative. The transfer paper, prepared somewhat similarly to the retransfer paper used in the autotype process, is soaked in very hot water, and, after the carbon tissue has been passed through cold water,

the two surfaces are brought together by the squeegee or by pressure. The two papers are then immersed in warm water of about 100°, and the backing to the pigmented paper stripped off. The development of the positive takes place as usual, and the paper bearing the print is hung up to dry, when it is ready for mounting and finishing.

Single transfer gives more delicate results than the double, no grain being present to mar the half-tones. The drawback to the process is the necessity of having a reversed negative.

THE POWDER PROCESS.

Under the head of printing processes comes what is usually known as the powder process. On the Continent it has been used with very good effect for the production of prints on paper, though in England its more familiar application is the reproduction of negatives or transparencies on glass. The rationale of the process is as follows:—

When a tacky body of an organic nature is brought in contact with potassium dichromate, and is allowed to dry as far as possible, and then exposed to light, it will be found that owing to the oxidation of that body by the chromic acid the tackiness will disappear in exact proportion to the intensity of the light acting on it. If a glass plate be coated with such a preparation, and be placed beneath a half-tone negative, the densities of the different portions of the negative will be represented by different stages of tackiness. A fine powder sprinkled over the exposed surface will adhere to the tacky portions in the ratio of the tackiness. Hence a picture will be built up which will be a counterpart of the negative, only reversed. From this it will be manifest that in order to obtain a positive picture a reversed positive must be employed; though a line engraving, for instance, may be directly copied by this method by allowing the back of the engraving to be in contact with the sensitive surface.

The following are the formulæ that have proved, in our hands, most successful:—

Obernetter's Formula.

Dextrine	1 drachm
White sugar	1½ drachms
Ammonium dichromate	½ drachm
Glycerine	2 to 8 drops
Water	3 ounces

Or,—

(*Woodbury's Formula.*)

Gum arabic	1 drachm
Glucose	¾ drachm
Glycerine	10 drops
Potassium dichromate	30 grains
Water	2 ounces

Whichever formula is employed, the solution should be filtered whilst warm, and be kept in a glass-stoppered* bottle.

A glass plate is next cleaned, and, if thought desirable, coated with a thin film of porous collodion, allowed to set, and then washed under a stream of water till all greasiness due to the solvents has disappeared. When drained, sufficient of No. 1 or 2 is taken in a clean glass measure, and allowed to flow over the surface two or three times. After pouring off the excess of fluid the plate is dried at about 150° F., or gently over a Bunsen burner, or Argand lamp, &c. Whilst still warm, and before the surface has had time to re-absorb moisture, the plate is placed in contact with the transparency or negative from which it is desired to obtain a reverse copy, and placed in sunlight for two or three minutes, or in bright diffused light ten or fifteen minutes. On removal from the printing-frame a faint image will be apparent, should the printing have proceeded far enough. After exposure to the air in order that moisture may be imbibed, plumbago† is applied with a large flat brush. The lights or shades are now represented by the graphite according as a negative or transparency has been superimposed.

When the image has been fully developed, the superfluous powder is gently dusted away, and the film coated with tough collodion, that given at page 150 for transferring films answering well. When well set, the plate is placed in water to allow the soluble gum and dichromate to dissolve out; and, if desired, the film may be detached from it by cutting round the edges with a sharp knife, and treating it as shown at page 150. The film thus detached may be made to adhere to any support

* A cork should not be used, as any extraneous organic matter is fatal to good results.

† The plumbago should be of the finest description; that used by electrotypers answers better than any other we have tried.

required, such as paper or glass, by giving it a thin preliminary coating of gelatine. By this detachment of the film the print evidently may be now reversed, if so required.

The application of this process to paper can be now understood. In practice it is found advantageous to give it a good smooth sizing of gelatine previous to coating with the above. Ordinary albumenized paper, the albumen of which has been coagulated by heat and afterwards washed, may be substituted.

PHOTO-MECHANICAL PRINTING.

All photo-mechanical printing processes for the production of half-tone hitherto worked out (with the exception of the Woodburytype process, to be described) are based on the same principle as the carbon or autotype process; viz., the insolubility in water (either hot or cold) of gelatine impregnated with a dichromate of an alkali, after exposure in a dry state to the action of light. Not only is insolubility produced, but also an inability to swell through the absorption of water. There is one other method of producing insolubility in gelatine, that does not prevent the absorption of water, viz., the addition to it of chrome alum, tannin, mercurous chloride, and various resins. These render the gelatine tough, and capable of withstanding a large amount of wear and tear.

Now if a layer of gelatine to which has been added potassium-dichromate and (say) chrome alum be exposed to light under a negative, and subsequently immersed in cold water, a little reflection will show that it is *all* insoluble in water; that where light has acted, there it will refuse to swell by the absorption of water; that where light has not acted, there it will absorb water. If a roller holding greasy ink be passed over the surface, the ink will be repelled from all the swelled portions, whilst it will adhere only to those parts on which light has acted. If a piece of paper be pressed down on such an inked-in surface, it is manifest that we shall obtain a positive print on its removal. With half-tone subjects the ink will only take in exact proportion to the time and intensity with which the light has acted on the gelatine surface.

WOODBURYTYPE PROCESS.

Mr. Walter Woodbury has successfully worked out a process of producing prints which may be classed under the head of photo-mechanical processes. For amateurs it would be difficult to undertake, owing to the apparatus that is necessary. The following is an outline of it. A film of sensitive gelatine is placed beneath a negative and exposed to light issuing from a fixed point, such as the electric light or to sunlight, the negatives being always in the same position to the rays. This may be effected by a mirror, or by constantly moving the negative into position. Sky-light may be used, supposing the light be admitted down a tube, all side light being thus shut off. The gelatine film, when fully exposed, is developed by washing away the soluble portion, and the picture is now in relief, the highest lights being represented by the lowest relief. When dried the gelatine print is placed on a soft metal plate, and driven into it by means of immense pressure, an hydraulic press being employed for the purpose. The metal sheet now becomes a mould, and is placed in a position on a metal table which forms part of the Woodburytype process. Beneath the lid is a perfectly flat glass plate, which is so adjusted by the knife that it makes actual contact with the metal mould. A solution of gelatine in a hot condition, containing pigments or dyes, is run into this last; a piece of homogeneous and specially prepared paper is placed over it, and the lid shut down. The pressure causes all the superfluous gelatine to exude, whilst that in the mould adheres to the paper. When set, this is lifted off, and a picture appears in relief, the lights and shades being formed by varying thicknesses of gelatine. An immersion in a weak solution of alum causes the gelatine to become insoluble, and the picture, when dried, is ready for trimming and mounting. It will be noticed that, like the Autotype process, the print is dependent for its shade on the transparency of the pigment. Hence, the more transparent the colour employed, the better the half-tones are likely to be.

The pictures produced by this process are now well known to most people, illustrations of cheap periodical papers being frequently executed by it. They are beautiful and delicate, and, as far as at present known, permanent. The greatest drawback to Woodburytype is the difficulty experienced in obtaining pure white for any large extent, as in the skies of landscapes. In the matter of skies, the difficulty is got over by manual means.

THE HELIOTYPE PROCESS.

This process is patented, and belongs to the Heliotype Company, being worked by Messrs. Edwards and Wright, of 61, Fleet Street.

In the heliotype process a film of gelatine is prepared on a glass plate, from which it is stripped when dry, and printed in the ordinary manner under the negative. The proper preparation of the film is of the highest importance, and unless properly performed the resulting prints will be imperfect.

The glass plate should be perfectly flat, and finely ground* on one side. To prepare it, the ground side is waxed with a waxing solution of white wax dissolved in ether. This is applied plentifully to the plate with a soft rag or cotton wool, and rubbed well in. As much as possible is then removed with a little ether or spirits of wine, till the surface presents an even and almost polished appearance. When required for use, the waxed surface of the plate is levelled by means of a spirit-level.

The following formula may be used in the preparation of the "skins" of gelatine for plates 22 by 16:—

No. 1.—Gelatine	$1\frac{1}{2}$	ounces
Glycerine	1	drachm
Water	12	ounces

The gelatine which answers well, and is cheap, is Nelson's No. 3 Flake. It should be allowed to swell in the water, and, when thoroughly swollen, should be melted over boiling water, and then the glycerine added. The temperature of the gelatine should not rise above 115° F., and the solution should be stirred till a perfectly even fluid is produced.

The sensitizing solution is made as follows:—

	For Summer.	For Winter.
Potassium dichromate of potash	22 grains	30 to 40 grains
Chrome alum	15 ,,	15 to 7 ,,
Water	12 drachms	12 drachms

This quantity, after heating to 100° F., is added to the prepared

* The polished surface of the glass may be employed by coating it with plain collodion containing equal parts of ether and alcohol, and about seven grains of pyroxyline, giving a horny film; or by a solution of india-rubber in benzole.

gelatine solution immediately before use; in fact, it should be added in the vessel from which the plate is to be coated, and stirred well, to form a perfect mixture. A piece of muslin is tied over the top of the vessel, and the gelatine allowed to strain through it on to the levelled plate. The surface having been covered, and the gelatine allowed to set, the plate can be placed away from all dust in a drying room through which a current of air of about 75° is passing. The plate gradually dries after twenty-four to forty-eight hours. It will keep sensitive on the plate for a week or more. The drying-room should be glazed with deep orange glass, and be kept nearly dark. Ventilation is a *sine quâ non*.

Another formula is appended, which has the advantage of giving an opaque white film:—

No. 2.—Gelatine	... ...	2 ounces
Glycerine	... ...	3 drachms
Water	... ...	9 ounces

This is prepared as before, but, just before use, and before adding the sensitizer, five ounces of skimmed milk (which has been warmed, to cause the cream to rise) are stirred up with the solution. The sensitizer is then added as before:—

	For Summer.	For Winter.
Potassium dichromate	22 grains	30 grains
Chrome alum	7½ ,,	5 ,,
Water	12 drachms	12 drachms

When dry the skins are stripped from the glass plate, the edges being raised by a penknife. It is best to allow them to stay for half an hour in a place where the temperature and moisture are similar to that to which they will be subjected during exposure. This will prevent any danger to the negative in the printing-frame. The skin is next placed, with the surface which was not in contact with the plate uppermost, on a board on which has been nailed black velvet. Two small strips of the skin are cut from its edge, and placed one over the other in an ordinary printing-frame, with an opaque mask over them, in which is cut a lozenge-shaped hole. This is exposed to the light with the skin. When the image of the hole is seen well defined on the nethermost strip of gelatine, the skin is withdrawn, and its surface which was in contact with the glass placed in contact with a *reversed* negative in a printing-

frame. (It is advisable that all the skin excepting that under the negative should be masked, to prevent the light acting on it.) One of the ordinary actinometers, prepared with yellow oiled-silk, is now brought into requisition. In the figure each number denotes the number of thicknesses of the silk; hence, when on a strip of sensitive gelatine 6 is seen, the light has penetrated through six thicknesses; when 7, through seven thicknesses, and so on. A half-tone negative of ordinary density requires the number 10 to be read on a piece of the sensitive gelatine placed beneath it; a clear line subject, not more than 6 or 7. Of course the actinometer is exposed in the same light as the skin*. When a negative is weak, it may only be half printed, and the continuating action (see page 133) allowed to act for twelve or twenty-four hours, when a more brilliant result will follow. In this case the preliminary sunning of the skin should be lessened, for obvious reasons.

3	4	5	6	7	8	9	10	11	12

Preparing the Transfer Plate.—A smooth metal plate of slightly larger dimensions than the skin (by preference pewter or nickelled steel) is coated with a solution of india-rubber in benzole, of the consistency of thick collodion (ordinary rectified lamp benzine answers every purpose); this is allowed to dry. The skin is then placed in water, with the prepared plate beneath, for two to three seconds, and both are withdrawn, leaving a layer of water between the sunned side of skin and the coated surface of the plate.

A large squeegee is next brought to bear, and the two surfaces brought into close contact, as in the double transfer carbon process (page 134). If any dust be between the two surfaces, great danger is run of blistering. When squeegeed down, the edges are brushed round with india-rubber solution, to prevent the water penetrating underneath and raising them. When the india-rubber is nearly set, the plate is immersed in water for periods varying from ten minutes to one hour.† When all the dichromate is washed out, the surface of the skin

* A small carte-de-visite pressure-frame is convenient for holding the actinometer.

† For a skin prepared according to No. 2 formula, ten minutes are sufficient.

is wiped dry, and is then ready for printing.* Blisters may now be apparent from dust or bubbles in the film; these can generally be forced out by applying the flat part of the hand, and squeezing them out to edge.

Printing from the Gelatine Picture.—The plate is now laid on the bed of a printing press, and small strips of paper are pasted with india-rubber over the edges of the skin on to the plate. A piece of bibulous paper is placed on the skin, and a good hard pressure brought to bear; this squeezes out most of the superfluous water, and leaves the plate ready for inking. Best lithographic chalk ink† should have been prepared with green oil, and be of the consistency of soft wax. The gelatine or india-rubber roller should be coated with this ink by rolling on a stone slab or slate. When coated, the roller is applied, evenly and smoothly, to the plate. Those parts acted upon by light will take the ink, whilst all others will repel it. If the picture be a half-tone one, a thinner ink of any colour made up with oil or Russian tallow may be used on another roller. This roller will not rob the plate of the first, on account of the thinness of the second ink, but will support detail in the high lights. Paper is now placed on skin, and, with a moderate pressure, a proof is pulled. Should white margins be apparent round the blackest shadows, or if the relief of the plate be too great, it is a sign that the surface requires "smashing down." This is done by placing bibulous or enamelled paper on the skin, and bringing down the platen of the press with a great pressure. This gradually diminishes the relief. More ink is applied, and proofs are pulled till satisfactory results are obtained. The surface of the skin between each proof pulled should be slightly damped with a sponge, and the excess of moisture got rid of‡ by the squeegee and blotting-paper. This keeps the whites clean as in lithography, and gives pluck to the resulting picture. Should the whole of the picture be too deeply printed, a little dilute ammonia (one part to four of water) may be sponged over the surface till the over-printing is no longer visible. In order to keep clean margins to the prints, a mask is cut of the shape

* Should a collodionized or india-rubber surface have been used, care must be taken that all the collodion or india-rubber is detached before printing. These polished surfaces have great advantage, having no grain.

† *All inks* should be *very* finely mulled.

‡ This should be done as quickly as possible, as, if not, the film is apt to become unequally damped, and give an unequal print.

required. The mask paper is prepared as follows :—Stout bank post is laid flat on a board, and boiled linseed oil is brushed over it. It is hung up by clips to dry, and is then ready for use. The mask, of course, is turned back between each inking-in of the picture.

Paper.—Any kind of paper may be used with "milk" skins, whilst enamelled paper answers best with the ordinary ones. The enamelled paper is prepared with "mountain snow" and gelatine; it is the subject of a patent, and hence cannot be manufactured excepting by licencees of the Heliotype Company. Of ordinary paper, that answers best which is found most adhesive when the tip of the tongue is applied to its surface.

Varnishing Prints.—The prints may be varnished, after pulling, if thought necessary, by a water varnish. This is made by dissolving shellac in boiling water to which a little ammonia has been added. As the shellac dissolves, more is added, stirring the solution the whole time. From time to time more ammonia and shellac must be added, till the varnish, on drying, leaves a brilliant surface. The varnish is filtered, and applied to the print with a flat brush.

Preparing the Gelatine Rollers.—The rollers are made of a solution of gelatine to which glycerine and castor oil are added. They are moulded in a cylindrical mould, on perforated wooden rods, similarly to the manner of preparing ordinary printing rollers. A roller for a first ink is coated with gold size and the fluff of blotting-paper; a second ink roller remains with the gelatine surface to take up the ink. India-rubber rollers can also be obtained, which answer well. The great secret of producing a good heliotype is to have first-rate rollers at command.

Failures.—The usual source of failure is the skins, which are not kept sufficiently free from dust, and in which air-bubbles are to be seen. In winter, blisters will appear from the above causes, as well as from too low a temperature of the water. The washing water should never be below 60°. If a skin be over-sunned, or be kept too long after sunning, a scum of ink will invariably be apparent on the high light. If a picture be over-printed under the negative, it may often be corrected by the judicious application of ammonia, as given above. If it be under-printed, thinner inks may be tried; but it is better to print a fresh skin than to waste time over experiment. Imper-

fections in the prints often arise from the imperfect use of the squeegee and blotting-paper, and from an uneven coating of the rollers with ink.

CAPTAIN WATERHOUSE'S PHOTO-MECHANICAL PROCESS.

All other kinds of photo-mechanical processes are, it is believed, those by which the gelatine film is printed from without removal from the glass plate. Captain Waterhouse's *modus operandi* is here given, as it is simple, and has proved most effective.

The negative must in all cases be reversed as for the heliotype process.* Plate glass three-eighths of an inch in thickness is used; it is ground on one side. When required for use, it is carefully cleaned and levelled in the ordinary manner. (Small wedges of hard wood answer well for this.) The gelatine solution, made as follows, is poured on the plate:—

No. 1.—Gelatine	... ...	1 ounce
Sugar	... ...	1 drachm
Distilled water	... ...	6 ounces

The gelatine must be allowed to swell, and be then dissolved.

No. 2.—Honey soap†	... ...	30 grains
Distilled water	... ...	1 ounce
No. 3.—Tannin	... ...	10 grains
Distilled water	... ...	1 ounce

The above quantities suffice for two square feet of plate.

When No. 1 is ready, Nos. 2 and 3 are mixed together hot, and poured gradually, with constant stirring, in No. 1.

The whole is then strained through two thicknesses of coarse cotton cloth, and poured evenly over the plates. (It is as well to let a very little run over the sides, as it secures adhesion of the gelatine to the surface.) Bubbles are broken by the point of a penknife. The plates are then covered over with a light paper cover, to prevent dust falling on them. They will set in

* Captain Waterhouse recommends, in some cases, that the film should be separated from the plate. Close contact is secured by this method.

† Calvert's medical carbolic soap answers well, and prevents decomposition of the film.

this country in about ten minutes' time, when they should be turned over and allowed to dry, face downwards, being supported on blocks of wood at the corners. Drying may also be carried on as for the heliotype process. When they are dry, they are ready for sensitizing; this is done by immersing them in—

Potassium dichromate	1 part
Water	20 parts

for about five minutes, when they are re-dried. When dry, any deposit at the back of the plate, and inequalities at the corners, are removed, and the plate is ready for exposure to light.

"This operation is performed in a pressure-frame in the same way as for ordinary photographs. It is advisable, however, to secure clean margins by shielding the borders of the negative by means of a mask cut out in yellow or brown paper, which should well overlap the edges of the printing plates. The mask is laid on the glass of the pressure-frame, then the negative in its proper position (should this be a transferred film, it is advisable to place a glass plate between it and the mask, in order to secure the most perfect contact); the sensitive plate is then rubbed over with a little powdered soapstone, to prevent its adhesion to the negative, and adjusted in its place over the negative, covered with a sheet of black velvet or brown paper, over which a thick glass plate is laid, and, if necessary, a few sheets of thick paper to give a good strong pressure, when the bars are shut down. The thick plate of glass has been found to give much sharper and more even contact than the usual backboard.

"The amount of exposure to light varies from about ten minutes in the sun for a clear line subject to from twenty-five to fifty minutes for a subject in half-tones, according to the subject and intensity of the light; but, as it is impossible to judge of the progress of the printing by inspection, it is necessary to use an actinometer as a guide to the exposure (see page 145).

"When the exposure to light is considered sufficient, the negative and mask are removed, and the *back* of the sensitive plate is then exposed to light for about five or ten minutes, to thoroughly harden the gelatine, and prevent it from swelling too much in the after processes. It is as well to carry on this second

exposure under a piece of ground glass; otherwise, if there should be any scratches on the back of the sensitive plate, or on the glass of the pressure-frame, they will show as white lines on the print; after this the plate is taken out of the frame; a little tallow is rubbed round the edges to prevent water getting underneath and stripping the film; it is then plunged in water and thoroughly washed till all traces of bichromate have been removed, and is ready for printing.

"*The Printing.*—The plates may be printed in the lithographic press, and then require to be fixed on a level stone with plaster of Paris. It has been found, however, more convenient, and in other respects better, to print them with vertical pressure in the ordinary Albion press; and in order to prevent their being broken, the bed of the press is fitted with two or three thicknesses of kamptulicon, besides a sheet of vulcanized india-rubber on which the plate rests. It is also desirable to place a sheet of white paper over the bedding, in order to enable the state of the plate, when it is being inked up, to be better seen.

"The plate, having been well soaked in water, is laid on the press, and, after having been wiped, to remove the excess of moisture, is inked in, if a line subject, with an ordinary lithographic roller charged with an ink composed of lithographic chalk ink thinned with a little olive oil, followed by a rolling with a smooth roller to clean away the superfluous ink; a mask of the required size is laid on the plate, over this comes the printing paper covered with a piece of soft felt to drive the paper well into the hollows of the plate, the tympan is lowered, and the impression pulled in the ordinary way. The plate is then damped, and the work goes on in the same manner without difficulty.

"For printing in half-tones, however, the process is somewhat different, and to obtain uniformly successful results requires considerable skill and experience. As far as we have gone the following procedure has given the best results.

"The plate is first inked in by means of a small leather hand-roller charged with stiff ink (rendered stiffer, if necessary, by the addition of a little Canada balsam), which takes only on the deeper shadows; the half-tones are then brought out by rolling in with a smooth lithographic roller charged with a lighter and softer ink. Rollers composed of glue, treacle, soap, and catechu have been found useful in certain cases for inking

in the plates, but, on the whole, the lithographic rollers are preferred. The impressions are best when printed on enamelled paper, but a smooth glazed printing paper also seems to answer well.

"Before putting away the plates after printing, they are washed with turpentine, followed by a very weak solution of caustic potash, to remove all traces of the greasy ink; they may also be treated after this with a mixture of gum and glycerine with advantage.

"*Corrections.*—A point that seems likely to greatly interfere with the extended use of the process was the difficulty of making corrections on the plates. I am glad to say that some experiments lately tried have shown that it is practicable both to insert and to take out or clear up details on the gelatine films.

"The insertion of details may be accomplished by two or three methods. The first is by writing in the required additions on the dry plate with a pen or fine brush, using an ink composed of bichromate of potash, used alone, or slightly coloured with Indian ink or indigo. After the additions are completed, the plate is exposed to the light for ten minutes or a quarter of an hour, till the bichromate is thoroughly reduced, and may then be washed and printed as usual. In some cases the same object may conveniently be accomplished by brushing over the part with solution of bichromate of potash, allowing it to dry, and then printing in the required details from another negative.

"Experiments have shown that details may be taken out by the aid of a solution of caustic potash or cyanide of potassium; and should a plate print dirty, it may be cleaned up and greatly improved by the use of a weaker solution of the latter substance.

"It often happens that the plates show too much relief in the lights, and that the ink will not take readily on the shadows or lines represented by the deepest hollows. This relief may be reduced by brushing the plate over with dilute nitric acid, one-sixth or weaker. The plate is then washed, and on inking-in the ink will take readily in the lines or hollows."

PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

PHOTO-LITHOGRAPHY is an important branch of photography, where the rapid copying and multiplying of line subjects is in question, and requires much care and dexterity to carry out. It is rarely to be found that the process is worked satisfactorily by a beginner, but that constant attention will render it practicable.

What is required is to obtain a print* from a negative in greasy ink, which may be laid down upon the ordinary lithographic stone or zinc plates. The principles of the process are the same as for the Autotype process, previously described at page 131.

SOUTHAMPTON PLAN FOR PREPARING TRANSFERS.

Make the following mixture:—

Potassium dichromate	... ...	2 ounces
Nelson's fine-cut gelatine	... ...	3 ,,
Water	... ...	50 ,,

The dichromate is dissolved in ten ounces of water, and added to the forty in which the gelatine† has been previously dissolved by the aid of heat. Select some good bank-post paper (very grainless) of a medium thickness. If this cannot be obtained, get ordinary thin paper as a substitute, and cut it into sheets a little bigger than the negative to be printed from. Strain the solution, and pour it into a dish through flannel, keeping up the temperature. This is best attained by getting a tin dish made, standing on four legs. (The dish holds water, which can be heated up to boiling point by a spirit lamp; and on the top of this should rest the porcelain dish containing the solution.)

The paper is floated about three minutes, and hung up by two corners to dry in a room which is non-actinically lighted, and is perfectly free from dust. When dry, the paper must be floated again as before. The sheets should be hung from the opposite

* Called a transfer.

† The gelatine should soak in water just sufficient to cover it, and then the remainder of the water should be added in a boiling state.

corners to those by which they were hung after the first floatation. Should it be considered desirable to coat the paper with gelatine first, and then sensitize, the dichromate may be omitted from the foregoing formulæ. The sensitizing is then effected by floating the prepared paper for one minute on a cold solution of—

Potassium dichromate	1 ounce
Water	15 ounces

In both cases it is well to pass the sensitized paper through a copper-plate or lithographic press, to obtain a fine smooth surface.

The sensitized paper will keep from about a week in cold to one day in hot weather.

The negative must be perfectly opaque in the whites, and transparent in the lines; no clogging or deposit must be apparent on them. It will be found that great pressure is required in the printing-frame to bring the paper and the negative in close contact throughout. The difficulty is increased considerably if the plates are not perfectly flat; hence, for these negatives, patent plate is recommended.

The amount of exposure to be given requires great judgment. With paper of a most sensitive character, a negative extremely dense in the whites, and the lines perfectly transparent, from half a minute to two minutes will be found sufficient if exposed in bright light, whilst it may take an hour in dull weather. The surest indication of proper exposure is when the lines appear a dark reddish-brown on a yellow ground. Should a negative be weaker in some parts than in others, the weak parts may be shaded by tissue paper, or paint applied on its film side.

The prints have now to be coated with greasy ink. At Southampton the following formula of preparation is used:—

Lithographic printing ink	8 ounces
Middle varnish	4 ,,
Burgundy pitch	3 ,,
Palm oil	½ ounce
Wax	½ ,,
Bitumen	1 ,,

The ink and varnish are first ground well together with a muller on a stone slab. The Burgundy pitch is next melted over a clear fire till the water is driven off. The wax is next added to it in small pieces, and finally the palm oil. These are

well stirred together. When properly melted, these should catch fire if a light be applied to them, in which case the bitumen is added, and it is afterwards ignited again. The ink and varnish are now added little by little, the stirring continuing the whole time. The pot is now taken off the fire, and when the contents are cooled they are poured into tins for storage. The condition of the ink is of the greatest importance. It must not be too soft, otherwise the sponge will become clogged on washing off in development. If the ink be too hard, it will be difficult to wash it off from the paper at all; in this case more palm oil should be added.

A small quantity of the ink should be taken, and laid upon a flat stone slab, and melted with turpentine sufficient to give it the consistency of honey. This is well worked with a lithographic roller on a smooth stone or square plate to a fine even surface. A print is now taken and laid face downwards upon this inked stone, and is passed once or twice through the lithographic press. On carefully raising it, it will be found to have taken a fine layer of ink, through which the detail will be faintly visible by transmitted light. The coating of ink may also be given by a sponge or hand roller, the paper being pinned firmly on to an even board, face uppermost. The finer the layer of ink, the better will be the developed print. These operations should, of course, be carried on in non-actinic light.

The print is now *floated, face uppermost*, on water of about 90° Fah. It is allowed to remain on this till the lines are seen in bas-relief on a swollen-up ground. It is next transferred to a zinc or glass plate placed on the slope, when warm water of about 150° is poured gently over it, and the soluble gelatine is removed by *gentle* rubbing with a very soft sponge. Should the inked soluble gelatine not leave the paper entirely at this stage, the prints should be *soaked* in warmer water for about an hour, when the sponging should be repeated. When the sensitized gelatine is moistened it becomes insensitive, consequently these operations may be performed by ordinary daylight. It should be borne in mind that the utmost care is required in the sponging: if the sponge be roughly handled the fine lines will be removed, and spoil the print for transfer. It should also be recollected that a constant flow of water from the sponge must be kept up to remove the inky gelatine after it is loosened, otherwise stains may result.

The prints, when freed from the soluble gelatine and ink, should be well washed in dishes of cold water, and hung up to dry. They are now ready to transfer to stone or zinc. It is better to leave them a day, however, before the transfer takes place.

TO MAKE A TRANSFER BY PAPYROTYPE.

This process is one patented by the writer, and is very simple of operation. Any tough paper is coated with a fine layer of gelatine, and subsequently treated with chrome alum or alum. It then receives another coating of gelatine of the same formula given for the Southampton method, substituting flake gelatine (for cheapness' sake) for the fine cut. The printing is not carried on to such an extent as in that method, but the lines must appear of a delicate fawn colour on the yellow background. After withdrawal from the frame the print is drawn through *cold water*, and is then squeegeed down on to a smooth zinc or pewter plate. If found necessary, the edges may be secured by strips of paper and india-rubber solution, as for the heliotype process. The superfluous water is then blotted off. A gelatine roller (of not too adhesive a character) is then charged with ink by rolling on a slab as follows:—

Best lithographic chalk ink	4 parts
Palm oil	1 part

This is now rolled on to the paper. The gelatine has only absorbed water where it has been unacted upon by light; consequently the print alone will take the ink, the "whites" remaining free. After the paper has been well charged with ink, it may be necessary to pass the roller smartly over the surface to remove any scum that may be adherent. The finished transfer will be found of the most delicate character, and surpasses in sharpness any one produced by other known methods. It is esssntial that but very little of the bichromate of potash should leave the paper, as the success in transferring mainly depends upon its presence. The transfer print is hung up to dry, and is then again exposed to light. The whole surface now becomes insoluble, and on re-damping, previous to placing on the stone, it has no tendency to stick, nor will the gelatine be squeezed away by the pressure of the scraper in the press. There will still, however, be sufficient adhesiveness left to retain

the paper in position. It will be noticed that this process has the following advantages:—

1st. The ink which forms the lines is not left on ridges of gelatine, as in the Southampton method.

2nd. There is no danger of removing the ink from the fine lines.

3rd. The ink may be applied till a satisfactory result is obtained.

4th. Two inks may be used of different consistencies; the thick ink will give solidity to the thick lines, whilst the fine lines will take a thinner.

5th. The surface of the transfer will have no tendency to slip, as the whole is partially adhesive.

It is not proposed to give a detailed description of the apparatus for lithography, or zincography, as a respectable manufacturer will supply them of a proper character. A list of the articles necessary to procure is given at the end of the book.

Both lithography and zincography depend on the property that a calcareous stone or mulled zinc plate possesses for absorbing or holding water, and on the fact that the grease is repelled by water; thus, where there is grease on a stone or zinc plate (placed by accident or design) the water is repelled. If a roller now be charged with greasy ink, and passed over the surface while still damp, the greasy ink will "take" in those portions where grease was originally on the surface, whilst the other portions remained unaffected. (The slightest trace of grease on the plate is sufficient to attract the ink from the roller.)

TO PREPARE A STONE FOR LITHOGRAPHY.

To prepare a lithographic stone for taking the transfer from a drawing, should the surface be uneven, or if a drawing has previously remained on for a considerable time, it may be necessary to grind it down, either by a stone of great size, or by an iron levigator. In both cases fine silver sand is sprinkled between the two surfaces, moistened with water. When the old work is removed, and the surface level, it is thoroughly washed with clean water, and polished with soft pumice stone. The pumice stone is moved backwards and forwards till all grain is removed. It is again washed with a sponge and water, and finally brightened up with snake stone. After washing it is

allowed to dry, when it is ready to receive the transfer. The whole of the polishing with pumice and snake stone will take about a quarter of an hour.

TO PREPARE THE ZINC PLATES FOR ZINCOGRAPHY.

The zinc plates are supplied by manufacturers, of proper weight, and ready planished. They should be about 10 B W guage. To be prepared for receiving a transfer, they must be grained. Brass founders' moulding sand is the best form of sand to use, as others, particularly silver sand, is apt to scratch the plate. Prior to use, it is sifted through a fine sieve of about 160 holes to the linear inch. A zinc muller is used to grind the surface after the sifted sand (moistened to the consistency of a cream with water) has been sprinkled on the surface. It is worked slowly round and round with a spiral motion, till the surface after washing appears of a uniform dull grey tint. Any traces of previous work must be obliterated, and all scratches must be ground out. The mullers should be kept free from all accidental grit, and be carefully washed before use. The zinc plate whilst mulling may be laid on any flat surface. A plate should be mulled immediately before use.

TRANSFERRING TO STONE OR ZINC.

The stone is slightly warmed either before a fire, or, what is more expeditious, by pouring over the surface a kettleful of boiling water. The heat in this case dries the stone, and leaves it sufficiently warm. The transfer is slightly damped, either by a moist sponge, or by damping a sheet of blotting-paper and placing it at the back. In any case, the top surface of the transfer should not be sponged or greatly damped.

Whilst this is taking place the stone is placed on the bed of the press, and it should be ascertained that the scraper is perfectly true. Should it not be so, it may be adjusted by placing a piece of sandpaper on a perfectly flat surface, and rubbing it down till it is perfectly level. The stone should now be "pinched" by the lever between the bed and the scraper, a piece of clean paper protecting its surface from the leather tympan. If the same amount of pinch be apparent at all parts of the stone, it is ready for use. If one end have less pinch than the other, the former must be raised up by laying under it a few

folds of paper, taking care that the folds gradually taper off as they approach the centre of the stone. When adjusted thus the stone must be passed two or three times through the press, to cause a still more accurate adjustment of the transfer. The transfer is then laid on the stone by two corners, and a couple of sheets of paper are laid over it. The tympan is brought gently down, and the whole is passed through the press two or three times. The amount of pinch given should be light for the first pull, it being increased for each subsequent one. The tympan is now raised, and if the transfer adhere tightly to the stone the scraper may be reversed, and the stone is passed through the press a couple of times more. In order to remove the transfer paper it may be necessary to soak it with water. This done, the surface of the stone is moistened with gum-water, and allowed to dry and coil. This is most important, as if it be used too fresh or whilst warm, the lines may spread, and give coarse and broken work.

The stone is fixed on the press, and the gum is washed off with a soft sponge, and the moisture distributed with a damping or cheese cloth. Ordinary litho ink having been worked to the consistency of honey, a little is laid on the roller and worked about on the ink slab till a fine even layer is spread over its surface. *Whilst the stone is moist* the roller is passed over it from time to time, that fresh surface may be brought to bear on the work. By this procedure it will be found that the lines take the ink. If a slight scum appear whilst rolling, it is probable that the stone is not sufficiently damp. A fresh application of the sponge and damping cloth, and a smart roll, will lift it, leaving the surface clean. The stone is next slightly etched, to prevent spreading of the lines. A very dilute solution of nitric acid in water effects this. A sponge moistened with this should be passed over the surface, and, after leaving it for two or three seconds, fresh water should be applied with the damping cloth. A little gum-water is then applied, wiped off, and the inking proceeded with again. It may happen that all portions will not take the ink alike—that portions are weaker than others; in this case, over those parts should be spread thick gum, and *through* it should be rubbed a little palm oil, spread on a small square of cloth. This *generally* gives the required intensity. Impressions are now pulled, inking-in between each.

For zincography the process is very similar; the transfer is

damped and passed through the press as above, the zinc plate being screwed on to a flat block of hard wood, so as to lie evenly and of sufficient height on the bed. When the transfer is removed the plate is well washed, and fanned dry. An etching solution is made thus :—

Decoction of galls	...	...	...	1 quart
Gum-water	...	...	...	3 quarts
Phosphoric acid	...	...	...	3 ounces

The decoction of galls is prepared by soaking four ounces of bruised Aleppo galls in three quarts of cold water for twenty-four hours; the water and galls are then boiled together and strained. The phosphoric acid is made by placing sticks of phosphorus in a bottle of water, so that the ends of the sticks are exposed to the air. The etching solution is brushed on the plate with a broad brush, and allowed to remain a few seconds; the excess is then wiped off with a cloth, and the zinc plate is fanned dry. It is then washed and rolled up as before. The first few impressions, either from stone or zinc, are generally feeble, and must be rejected.

A GUM PROCESS.

Take Rive paper, and brush over it a solution of—

Picked gum-arabic	...	...	...	25 grains
Potassium dichromate		...	...	85 ,,
Water	...	...	...	1 ounce

Hang it up to dry. This will be accomplished in about half-an-hour in warm weather.

The sheet of paper must be placed under the nagative as usual, and exposed to the light. When every detail is clearly seen, the paper should be withdrawn.

Take ordinary printing paper, and soak alternate sheets in water, blotting the excess of moisture off in blotting-paper. Make these in a pile (about six sheets of moist and dry will be sufficient). Place the printed paper on the lithographic stone or sheet of mulled zinc, place a dry sheet of paper on its back, and then on it place the pile of damped paper. Finally, place a sheet of zinc or other flat surface on the top. The stone or zinc plate and its load should next be pressed under an ordinary book-binding press, and a considerable pressure brought on to it. It should be left under this for half-an-hour.

The paper is then removed from the stone. Those parts of the gum which were rendered insoluble will leave the stone with the paper, the remaining portions adhering to it. After thorough drying away from light, a little oil is poured or brushed over the surface. The gum protects the white portions of the print from its action. The stone may be cleaned from the gum with a sponge and tepid water, and the ordinary lithgraphic process may then be proceeded with.

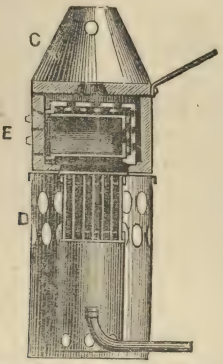
The process is simple, the drawback being that the gum penetrates to a considerable depth through the surface of the tone, rendering the preparation for fresh work tedious.

PHOTOGRAPHIC ENAMELS.

There are two methods of producing photographic enamels which have been practised in this country: the one by what is called the dusting process (similar, in fact, to the powder process, described at page 143), metallic powder being employed instead of the plumbago; whilst the other is dependent on the production of a transparency in collodion, the image being toned by various metallic compounds. The first process will not be described, as it is believed that the second is capable of giving very superior results, and is more within the reach of any one. A muffle for this process is absolutely essential. A form for placing in an ordinary fire is supplied by many dealers; but, when feasible, it is advisable to have one which is heated by gas, as with it there is no danger of discolouration, due to smoke, sulphur, &c., which is sometimes the case when coal or coke is the source of heat. Fletcher, of Warrington, supplies a most excellent gas furnace for the purpose (see diagram on next page). It can be fitted into any ordinary gas supply, and attains sufficient heat in a quarter of an hour to fuze any enamel placed within the muffle.

The first step in the production of an enamel is to produce a fully developed transparency of the subject to be copied. This is secured in the camera in the usual way, and when fixed should appear very vigorous, though with half tones of a most delicate character. The next operation is to detach the film from the glass plate. This is effected by placing it in distilled water (to which, if the film be refractory, a little dilute sulphuric acid has been

added), and after a thorough soaking it can be removed by a camel's hair brush, deftly applied at one edge. The sulphuric acid is sometimes an advantage if the collodion be tender, as it toughens it; but great care is requisite to ensure that all traces



E is the muffle door closed with fire-brick, as shown in section; D shows the draught-holes opposite the burners, which are a series of pipes; C is a movable piece to which is attached a chimney. The muffle part can be removed, and an alternative portion is supplied for heating crucibles, &c.

of it are eliminated before proceeding further. The writer has in many cases toned the transparency before detaching the film from the glass, but the action is slower, owing to the fact that only one surface is open to the deposit of the metal.

There are several toning solutions which are all effective, though the colour of the finished enamel varies according to the metal employed. It may here be remarked that there are two methods of burning a picture on an enamel—one in which the image is absolutely burnt into the plaque; the other in which a soft flux is melted over the metallic image, giving it merely a glaze. The first plan is real enamelling, the metal forming a compound with the composition employed; while with the latter the image is merely superficially protected, and is not, therefore, so likely to resist injury. For absolute success with the first method, it is merely essential that all silver should be entirely eliminated from the image; for if a true silver compound be formed, the image will have a dirty canary colour, on burning, which no subsequent treatment can efface, though by regulating the temperature some operators can burn in just

sufficiently to cause the image to sink into the enamel. The composition of the plaques materially affects the tone, hence there is often a discordance in the results obtained by different operators, unless the same materials be used. With plaques supplied by Atkinson, of Liverpool, the platinum toning bath gives to the writer a rich velvety black colour. The toning bath employed is—

Platinum tetra-chloride*	...	...	...	1 grain
Water ...	...	...	...	20 ounces

to each pint of which 4 drops of concentrated nitric acid are added. This gradually converts the film of the image into silver chloride, and causes a consequent deposition of platinum. As one equivalent of platinum displaces four of silver, the reason why a rather dense transparency is required is apparent. The toning operation can scarcely be continued too long when the transparency is of proper intensity.

Another toning bath, suggested by Herr Grune, is to tone first with platinum, and then to remove the film to a solution of uranium ferricyanide. Half a grain of uranium nitrate and half a grain of potassium ferricyanide are dissolved in a pint of water, and this solution is employed. When a slight browning action is observed, the fuzed image will have a sepia brown tint. Iridium chloride of a strength about the same as the platinum chloride is also employed by some enamellers with very good effect, the tint of the picture produced being a delicate grey.

After well washing,† the film should be treated with ammonia solution, half ammonia and half water. This dissolves out the silver chloride, and leaves an image formed of metallic platinum and silver. To eliminate the latter after thorough washing in distilled water, it is treated with nitric acid and water (half acid and half water). This finally frees the image of all traces of silver if it again be thoroughly washed.

The picture thus finished is allowed to remain floating in a dish of distilled water, and the plaque is brought beneath it. They are brought out of the water together, the film clinging to the surface of the plaque. A penknife is then brought into requisition, and the film is trimmed by it so as just to cover the edge of the latter, and after a few strokes of a fine camel's hair

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* Previously neutralized with sodium carbonate.

† The film must be thoroughly well washed, in order to free it of any trace of the platinum solution; otherwise, by the subsequent treatment, a deposit of the metal may take place on the whites, and spoil the picture.

brush, collodion and enamelled surface will be found to adhere together without crease or wrinkle. After drying thoroughly, the plaque is placed on a small sheet of cast iron or a small brick, and placed in the muffle, and the heat applied. The process of burning-in can be readily watched, and the instant that it is complete may be judged by the appearance of the surface of the enamel. First, the collodion film* disappears, next the whole plaque becomes red hot, and the image seems to disappear; a few seconds after this effect is observed, it should be withdrawn, and on looking, it will be found that the burning-in is finished at this stage. The enamel appears dull and devoid of gloss, and it is consequently necessary to apply a glaze to it. The glaze employed is that known as *soft glaze*, as supplied by various china manufactories. This can be shaken up with plain collodion, so that on coating the plaque with it the image is completely hidden by the white surface due to the fine powder. When dry, another burning is given, but only to such an extent that the soft glaze becomes liquid, after which it is withdrawn. It frequently happens that two or more glazings are required before the right lustre is obtained.

The art of enamelling is practised by very few photographers; those whose productions are worthy of notice could be named on the fingers of one hand. The method given above is founded on that of Herr Grune, and it is believed that most enamels are produced in a somewhat similar manner.

PHOTO-RELIEFS.

The production of satisfactory photo-reliefs of etchings, &c., has long been a desideratum in the printing trade, and many attempts have been made to secure such. The following process answers well for their production in zinc.

A transfer in hard transfer ink from a negative is made as if for lithography or zincography. A one-eighth of an inch zinc plate is then thoroughly mulled as described at page 152, after which it is rubbed down to a smooth surface with pumice, and then with stick charcoal. The appearance of the plate should be such as to be almost polished, and all visible grain

* If the sulphuric acid used in the first soaking to detach the film have been too strong, it often explodes, and carries away the image with it.

should be absent, particularly if the work to be reproduced be fine. The transfer is then placed on it, and passed through the lithographic press in the ordinary manner, and a good firm impression left on the prepared surface. The plate is now dusted with fine resin or colophony (the dust being passed through a muslin bag to prevent any lumps adhering to the plate), any not attached to the greasy ink being blown off. A solution of—

Hydrochloric acid	...	...	...	1 part
Water...	...	...	...	500 to 750 parts

is next prepared, and placed in a flat dish which is sufficiently large to hold the plate, and which can be rocked mechanically. The solution should be of such a depth that when the dish is fully tilted in one direction the surface of the plate should be a little more than half bare. The surface of the zinc bearing the picture is next flooded with a dilute solution of copper sulphate (10 grains to the ounce), and a fine *black* deposit of precipitated copper is left.

In this stage we have a zinc-copper couple, the contact between the two metals being so complete that the voltaic action is able to decompose a variety of liquids hitherto not easily acted upon. The coppered plate is immersed in the acid solution, and an immediate evolution of hydrogen shows that an action is taking place, the zinc gradually being attacked where the copper is opposed to it. It should be remarked that the acid solution is so dilute that it has no susceptible effect on uncoated zinc, hence those portions covered by this greasy, resinous transfer ink are not acted upon. The dish containing the acid should be constantly rocked, to cause the bubbles of gas to disappear, and on this depends the success of the process. After twenty minutes in this solution, the slow evolution of hydrogen will show that the acid is nearly exhausted. The plate should then be withdrawn and washed under the tap. It should next be warmed to soften the ink and the resin, and more ink should be rubbed into the lines, as is done in rubbing up a lithographic impression. The dusting process is again resorted to as before. The copper solution is applied, and after washing, the zinc is again immersed in an acid solution (this time of double the strength of the foregoing), and the same motion given to the dish. These operations are again and again repeated, the warmed ink and resin gradually running down the raised lines, and filling

LES TROIS MAMELLES, MAURITIUS.

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in the close spaces. When a sufficient depth is given to the close lines, the large portions of the block which should print white may be sawn out with a fine saw. The accompanying plate was produced in the manner described above. When printing off large numbers, zinc is liable to damage, and printers seem to object to this metal. Electrotypes may be taken from the zinc reliefs, and when faced with steel, leave nothing to be desired.

It should be remarked that the employment of copper prevents local electrical action in the zinc when iron or other impurities are present, hence the metal may be that ordinarily to be obtained in commerce. The most successful worker in zinc, as far as the writer knows, is Gillot, of Paris, whose productions are indistinguishable from the best woodcuts. The economy of this method of producing relief blocks is the fact that two or three square feet of them may be executed at the same time, very little additional labour being required.

A very short way of obtaining blocks for relief printing is by treating a lithographic stone in a similar manner (omitting the copper solution), and using a hot iron for melting the ink and the resin. A mould is obtained from this in wax, paraffin, or gutta-percha, and an electrotype taken. Great depth is more easily obtained on a lithographic stone than on zinc if the manipulations are carefully attended to. Constant practice is required in these processes to ensure success. There are other processes practised at Chatham for obtaining direct reliefs in copper, but their publication would be premature.

HINTS ON APPARATUS.

THE CAMERA.

For out-door and landscape photography the camera should be of the lightest possible make, as far as is compatible with rigidity. That form which is known as "the bellows," with parallel sides, when properly made, fulfils these requirements better than any other. In it the lens remains fixed, whilst the ground-glass is made to move to attain proper focus. This will be found of great convenience. *Every camera* should have a "swing-back;" that is, the ground-glass should be made to hang plumb when required, supposing the camera to be tilted. For portraiture the same class of camera may be used, though

a heavier kind for this purpose is not objectionable; the body may be rigid, in which case focus would generally be obtained by movement of the lens. For hot climates and rough usage brass binding is recommended for the woodwork, and Russia leather for the bellows; cockroaches and white ants will not attack the latter.

For an amateur photographer, $8\frac{1}{2}$ by $6\frac{1}{2}$ is recommended as a suitable size. He can, unaided, conveniently carry this size, together with a dozen dry plates. Care should be taken that the inside of body is coloured of a *dead* black, otherwise reflections on to the plate may occur, giving a hazy appearance on portions of the negative. The mode of testing this instrument will be patent to all; the chief defect to be looked for being a want of coincidence of the rough surface of the ground-glass with the plane of the silver wires which support the sensitized plate in the dark slide. Well seasoned mahogany is the wood most suitable for a camera, and it should be borne in mind that polish gives greater durability to it.

The camera legs should be of such a length as will allow the lens to be raised at least five or six feet high. This rather exceeds the average height of the eye. There are various portable folding legs extant for rigidity and convenience; though rather heavy, there are none better than Paget's pattern, to be got at Meagher's, 21, Southampton Row, London.

The Scenograph is a neat little camera adapted for taking $6\frac{1}{2}$ by $4\frac{3}{4}$ pictures. It is very light, and is very rigid considering its small height. The legs form a walking stick by a neat arrangement. To a careful (*not a rough*) photographer the scenograph is worthy of attention.

LENSES.

For landscape photography a single lens gives the most brilliant picture. It is more rapid than any other, as the loss of light from reflection by the surfaces is the least possible. For architectural subjects a doublet or triplet lens is necessary, as the first-named lens distorts marginal lines. For a complete outfit it is well to have four lenses:—(1) An ordinary single lens; (2) a wide-angle single lens; (3) a doublet lens; and (4) a wide-angle doublet. If only one lens can be provided, 3 should be chosen in preference to the others. For stereoscopic work the same applies. For portraiture a portrait doublet

should invariably be used. By consulting a catalogue of some well-known maker, all information necessary for guiding the choice will be found.

English made lenses are to be recommended in preference to those of foreign make. They are more expensive, but are better finished, and are always achromatically corrected; that is, the chemical and visual foci are made to coincide.

BATHS.

Porcelain baths answer well till the glaze gets cracked; they must then be put aside, as contamination of the bath solution may result. Glass baths in a wooden case with water-tight top are to be most recommended, as the solution can be inspected from time to time, also any accumulated dirt on the inside will be immediately noticed. One precaution should be observed in selecting glass baths, viz., to ascertain that the wooden case does not fit tightly on to the glass. The bottom of the case and its top should be padded with thick felt, to prevent breakage by any casual jar. Ebonite is too brittle and too much injured by climate, whilst gutta-percha is generally too impure a material to be substituted for glass.

DIPPERS.

Ebonite dippers answer in a temperate climate, and are not liable to break. A hook at the back to catch the edge of the bath, which just prevents it touching the bottom of the bath, is an advantage. Any deposit thrown down is thus undisturbed. Makeshift dippers may be manufactured from a long strip of glass, cementing a smaller strip on to it. Silver wire dippers, perhaps, are the best, as they prevent an accumulation of the bath solution at the back of the plate.

THE DARK TENT.

There are a considerable number of dark tents which are capital for field work. A box tent is handy, as it will carry all the chemicals necessary for a day's photography. Rouch's pattern is excellent; that as modified by the writer has a few improvements which add much to the comfort of manipulation. A tent should be of such a size and weight that it can be conveniently carried by a man. For hand carriage it should not weigh more than 25 lbs., including chemicals. Stillman's

manipulating box is handy, and also the knapsack tent, for small pictures. When a tent is erected it should, if possible, be placed in the shade. The window should invariably be turned away from direct sunlight. The tent should be tested by placing in it a sensitized plate for a couple of minutes, whilst the window is darkened. Should the plate remain unaltered by development it may be taken for granted that the tent is fit for use. The window glass should be tested as above.

DEVELOPING CUPS.

Glass developing cups are far superior to any other, as they can be kept clean, and the amount of solution in them can be accurately seen, which is not the case with ebonite cups. In the field it is useful to have a couple of the latter ready at hand in case of accidents with the former. For plates up to 10 by 8, the children's small tumblers, sold for about a penny, answer every purpose, and they are difficult to break.

PNEUMATIC PLATE-HOLDERS.

There is no better plate-holder than the india-rubber globe pattern. It is convenient to have the globe enclosed in a cylindrical box open at the lower end.

NON-ACTINIC GLASS.

The orange or red glass used for the dark room or tent should be tested. If a prism, such as a drop from a chandelier, be at hand, this is easily done. The eye should be brought close to one edge of it, and white light from a window be allowed to pass to it through the glass to be tested; if the violet, blue, and green rays be cut off, the glass is non-actinic. A practical test is to lay a piece of sensitized silver chloride paper beneath the glass and expose it to sunlight for half an hour: if the paper remain very nearly white, the glass will answer for ordinary photography. With bromide plates the glass should be tested by exposing silver bromide beneath it.

NON-ACTINIC SCREENS.

A useful screen for developing dry plates at night by candle-light can be made as follows:—Take a sheet of cardboard of the size of about 2 feet by 1 foot 6 inches. Lay off from the 2 feet side distances of 6 inches from each corner, and with a penknife cut half through the card in a line parallel to the ends. These

will form flaps, which can be folded over to meet in the centre. From the centre portion, and six inches from the bottom, mark out a square of 8 inches; cut round three of the sides, but only half cut through the bottom side, the penknife being applied from the inside of screen. This will allow a square flap to fold downwards towards the outside. On the inside of the opening may be pasted or hung two or three folds of orange paper; or a sheet of gelatine (made by preparing a skin on a glass plate, as for heliotypy—page 143—and dyeing it deeply with aurine or aniline scarlet) may be glued to it. The candle is placed behind the screen, which should stand, supported by the two wings, in front of the operator. When packed for travelling the flaps are folded up, and it can be placed in the portmanteau with the greatest facility.

EVAPORATING DISHES.

The best evaporating dish is made of platinum or silver.* A substitute for the latter metal can be made by using one thickly electro-plated. It lasts a long time, and is not a quarter the price. Berlin porcelain is generally used. Dishes made of this material should be at least six inches in diameter to use with comfort. A metal dish enables a solution to be evaporated to dryness without burning the residue or driving off the water of crystallization.

FUNNELS.

Ribbed glass funnels will be found better than those made with smooth glass, as the air which is displaced can, with the former, find a ready exit. Gutta-percha funnels should be used with caution, as it is impossible to ascertain if they are clean.

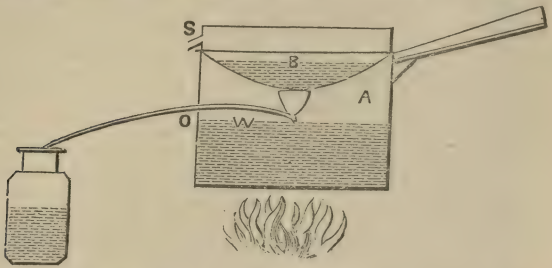
STILLS.

A still should be of a portable character. It should be ascertained that the worm of the condenser is not made of lead or any lead compound. The top of the still should be of such a shape that any water which may be projected upwards during ebullition shall not be able to travel down to the worm.

The following is a makeshift, which is in imitation of a well-known Indian contrivance. A is a saucepan of large size; B is

* When a silver dish is used, no nitric acid must be added.

the lid inverted. If a tinsmith be at hand, a spout, S, should be soldered into the lid, that the heated water in B may be changed with cold. A small hole is bored in the side of the



same pan at O, into which is fitted a tobacco pipe as shown in the figure. The surface of the water, W, is below the pipe. When the water boils the steam is condensed on B, trickles down to the tobacco pipe, and is collected at the other end of it. The first pint of water distilled should be rejected, lest it be contaminated in any way.

DISHES.

Porcelain dishes are recommended in preference to any other kind. It is easily seen if they be clean, and they are easily scoured out after use. Ebonite dishes may be used for hypo-sulphite. They should be constantly cleaned from a sulphur deposit which forms on the bottom.

DRAINING BOXES.

A draining box which opens at the top and bottom is handy for outdoor work. For economy of space each pair of grooves should be capable of holding two plates back to back.

DRY PLATE BOXES.

To store dry plates, resort may be had to the plan of separating each one from the other by two strips of cardboard or thick paper bent zig-zag (as a hem is prepared for stitching), one at each end of the plate. Between each fold is placed a dry plate; the whole bundle should be bound round with twine, and wrapped in non-actinic coloured or opaque paper. It is necessary, however, when the parcel is broken into, to have some

mode of storing the plates. This is best done by using a grooved box with a removable lid. The lid should slide into grooves, and lock; an inner loose lid, with a spring attached to its top, and strips of *unvulcanized* india-rubber placed across its ends, should rest on the edges of the plates. The spring is pressed down on the upper lid, and this presses on the plates, clamping them tightly together in position; two other strips are placed similarly on the inside of the bottom of the box on which the plates rest. Each pair of grooves should hold two plates back to back. The whole of the inside of the box is usually lined with tinfoil; this allows dust to be got rid of, and prevents moisture permeating.

METHOD OF CARRYING NEGATIVES ON TOUR.

A tourist often finds the transport of a large quantity of glass in his travels a great source of discomfort, and to enable him to avoid it the following plan has been successfully followed by the writer. The method is that suggested by Mr. Walter Woodbury, who has published it in a "brochure" on the scenograph. The application thus made refers to emulsion plates, but the writer has found it equally adaptable for all kinds of films. After a negative has been taken, fixed, and dried, a sheet of gelatinized paper (see page 152) is taken and immersed in cold water for a few seconds; the plate is placed beneath it, and the two are brought out of the water together as in the carbon development. The surfaces are brought in contact by a squeegee, and when the gelatine has sufficiently adhered, but is still damp, the film is stripped off. When dry, the reversed negative on paper is placed between the leaves of a blank book, and thus transported. The glass is of course serviceable for the preparation of other plates. To re-transfer the film to glass again, a plate of the proper size is flowed over with a solution of gelatine (1 ounce to 10 of water, to which 3 grains of chrome-alum are added) and dried. The film with the paper is immersed in cold water, and the plate brought beneath it and squeegeed as before. This time they are allowed to dry thoroughly, after which they are immersed in hot water. The gelatine from the paper dissolves away, and leaves the film on the glass, that which has been rendered insoluble by the chrome alum retaining it. The process is simple, and never fails with ordinary care, and the tourist will soon learn to appreciate its advantages.

APPENDIX.

TO PURIFY WATER FOR PHOTOGRAPHIC PURPOSES.

The importance of using chemically fit water in photography is not to be over-rated. When distilled water cannot be obtained, resort must be had to purifying it to the best of our ability. The water should be roughly tested, to see what impurities it contains.

First add a drop of nitric acid to (say) one ounce of water; warm, and add a few drops of a solution of potassium sulphocyanide. A red colouration will show the presence of iron sufficient to be injurious in making up a silver bath. Next add to a fresh portion a little ammonia and ammonium oxalate: a faint precipitate will show lime present to the extent of about six grains per gallon. This may be neglected. If more than a trace of precipitate be apparent, the water must be purified from the lime. Next boil the water. A precipitate will show that the lime is present as a bicarbonate; if not, it is present as a sulphate. Magnesia is much less common in water than lime, and is present generally as sulphate (Epsom salts). Supposing all be present, and it is necessary to render them innocuous, we must proceed as follows:—First the water must be boiled, to get rid of carbonic acid, and to precipitate the carbonate from the bi-carbonate of lime; this will leave about two grains per gallon of the calcium carbonate in solution. Next add ammonia till the water is slightly alkaline to test-paper. This will precipitate any iron present (probably present as carbonate), leaving carbonate of ammonia and a little free ammonia in solution. Boil the water again till all the ammonia is expelled. Next add a grain to the ounce of water of silver nitrate, and place it in a blue or white glass bottle in the sun. This will precipitate the carbonates and chlorides present, and also the organic matter. Next add a few drops of a solution of barium nitrate to precipitate the sulphuric acid that may be present in the sulphates, and filter. The water thus purified will make an excellent bath water. If water be only required for washing dry plates, &c., it should be boiled and passed through a charcoal filter, when it will be fit for use.

Rain-water should be passed twice through a charcoal filter to

render it fit for use, that is, supposing it has been collected from the roofs of houses.

Water collected from snow is generally quite free from every hurtful impurity.

THE PREPARATION OF SILVER OXIDE.

If to a solution of silver nitrate a solution of potash be added, a precipitate will be formed. This is the silver oxide. The potash should be added till no further precipitation takes place. The oxide should be allowed to settle, when the supernatant fluid should be decanted off (a syphon arrangement is very convenient), and fresh distilled water added to it. This, in its turn, after the oxide has been well stirred, should be decanted off. The operation should be repeated five or six times, until a drop of the water evaporated to dryness on a clean piece of platinum foil leaves no residue. The chemical reaction is as follows :—

$$\overbrace{2AgNO_3}^{\text{Silver Nitrate.}} + \overbrace{2KHO}^{\text{Potash.}} = \overbrace{Ag_2O}^{\text{Silver Oxide.}} + \overbrace{2K,NO_3}^{\text{Potassium Nitrate.}} + \overbrace{H_2O}^{\text{Water.}}$$

The chief use of silver oxide is to neutralize a bath in which there is an excess of free acid, the nitric acid forming with it a fresh silver nitrate.

From this it is apparent that the oxide should be added till there is a slight deposit left.

The silver oxide is slightly soluble in water, hence on adding it to a bath solution it may be necessary to add a few drops of a dilute solution of nitric acid (one part of acid to ten of water).

TO PURIFY A BATH SOLUTION BY BOILING DOWN.

The bath should be placed in an evaporating dish, and be evaporated down to dryness, and fused till all the frothiness that may be apparent has subsided. It will be seen that the organic matter has reduced a portion of the silver nitrate to metallic silver. When sufficiently cool, add enough nitric acid and water, 1 to 10, to redissolve this by the aid of heat. Now evaporate to dryness. The nitrate should again be re-dissolved in ten ounces of water, and be once more evaporated to dryness, when it will be found that it is fit for making up to strength, all excess of acid being dissipated.

Boiling down a bath rids it of the alcohol and organic matter, but leaves the nitrates of cadmium, &c., unchanged. When surcharged with these latter, the silver should be precipitated.

NEW BATHS FROM OLD.

First Method.—Dilute the bath to twice its bulk, and filter out the iodide of silver which will be precipitated.

In the filtered bath solution place strips of copper or copper wire, and leave them undisturbed for twenty-four hours. This will throw down the silver in a metallic state, leaving the copper and other nitrates in solution. Take two or three drops of the *solution*, and test for the absence of silver by adding a little solution of common salt to them. If no white precipitate appear, the conversion into metallic silver is complete. Carefully decant the supernatant fluid, and withdraw all the copper visible; wash the silver in three or four changes of water until the blue colour due to the copper nitrate is absent; all the other salts will be washed away with the copper nitrate. Place the metallic silver in a large porcelain dish, and add *gradually* one drachm of pure nitric acid (1·36, the strength of the British Pharmacopœia) to every 150 grains of silver nitrate (this can be estimated by the argentometer) in the original bath solution. The silver will gradually dissolve, but will be much aided by the application of heat. The solution will now have a greenish colour, from small particles of copper which have fallen, coated with silver, from the original wires or strips. These small particles of copper will be dissolved by the nitric acid, and will form copper nitrate. Boil down the solution to small bulk—till it begins to spurt. This will free it of any great excess of nitric acid. Next add distilled water to it till it has a slightly larger bulk than it had before boiling down. Next add silver oxide, little by little, till the blue or greenish colour has entirely disappeared. This will precipitate the copper oxide from the copper nitrate, setting free the nitric acid, which, in its turn, will combine with the silver oxide. The copper will fall as a black powder mixed with any excess of silver oxide there may be. Take one or two drops of the solution in a measure, and add a drachm of water, and then add ammonia to it till the precipitate first formed is re-dissolved. If no blue colour is apparent, the substitution of the silver for the copper is complete; if not, more silver oxide must be added till the

desired end is attained. Distilled water must next be added till the strength of the bath is that required. This can be tested by the argentometer. An emulsion of silver iodide *may* here appear. If it do, no matter. When the solution is filtered the bath is fit for use, being chemically pure, neutral, and charged to a proper extent with iodide of silver.

Second Method.—Dilute and filter the bath as in the first method, and place in the solution strips of zinc. The silver will precipitate, as with the copper; small particles of zinc will also fall with the silver, and must be got rid of. This may be done by two methods—either by dilute hydrochloric acid, or dilute sulphuric acid (one part of acid to twelve parts of water). The silver is collected from the solution either by filtration or decantation, and is well washed. It is then placed in a porcelain dish, and is boiled with the very dilute acid (about one part to one hundred of acid). This dissolves the zinc, and only slightly attacks the silver. The mass is thrown on the filter, and washed well with boiling distilled water. If sulphuric acid have been used, this washing dissolves out any silver sulphate which may have been formed. The silver is dissolved up by nitric acid as in the first method. If hydrochloric acid have been used, there will remain a little silver chloride, which will be filtered out.

TO MAKE SILVER NITRATE.

Silver coins are mostly alloyed with tin or copper. In both cases the coin should be dissolved in nitric acid diluted with twice its bulk of water. If tin be present there will be an insoluble residue left of stannic oxide. The solution should be evaporated down to dryness, re-dissolved in water, filtered, and again evaporated to dryness. It will then be fit for making up a bath. If copper be present, the solution must be treated as given in the last article, where the oxide silver is substituted for copper oxide.

EASY TESTS FOR THE AMOUNT OF SILVER NITRATE IN A SOLUTION.

Take half an ounce of the solution to be tested, and precipitate the silver as chloride by adding a slight excess of hydrochloric acid or common salt. Filter the solution off, and dry the filter paper and the chloride over a water bath. The

chloride can then be easily removed from the filter paper, and should be weighed. The weight multiplied by 1·18 will give the amount of silver nitrate.

Another very pretty method is as follows:—Measure with a pipette (or dropping-bottle) one hundred drops of the solution to be tested; rinse the pipette, and drop from it, into the silver solution, a solution of dried salt and water (thirty-five grains to the ounce), till no more precipitate of silver chloride is seen to form. The number of drops added to the silver solution will be the number of grains of nitrate of silver in the ounce of bath.

There are two methods of ascertaining when no further precipitate is formed:—first, by adding drops of potassium chromate (*not bichromate*) to the salt solution, and noting when the precipitate finally has a permanent red tinge after stirring; or the solution of salt may be placed in a stoppered bottle, and be shaken between each addition of the silver. The silver chloride agglutinates by shaking, and a fresh precipitate is seen to form at once on adding another drop of silver. When all the sodium chloride is precipitated, the solution remains milky.

UTILIZATION OF SILVER RESIDUES.

All paper or solutions in which there is silver should be saved, as it has been proved by experience that from 50 to 75 per cent. of the whole of the silver used can be recovered by rigid adherence to the careful storing of "wastes."

1. All prints should be trimmed, if practicable, before toning and fixing; in all cases these clippings should be collected. When a good basketful of them is collected, these, together with the bits of blotting-paper attached to the bottom end of sensitized paper during drying, and that used for the draining of plates, should be burnt in a stove, and the ashes collected.* These ashes will naturally occupy but a small space in comparison with the paper itself. Care should be taken that the draught from the fire is not strong enough to carry up the ashes.

2. All washings from prints, water used in the preparation of dry plates, old baths, developing solutions (after use), and old toning baths, should be placed in a tub, and common salt added. This will form silver chloride with the nitrate.

* In large establishments the films from rejected negatives may be added.

3. The old hyposulphite baths used in printing, and the solutions of cyanide of potassium, or sodium hyposulphite, used for fixing the negatives, should be placed in another tub. To this the potassium sulphide of commerce may be added, or else a stream of sulphuretted hydrogen passed through it till no more precipitation takes place. Silver sulphide is thus formed.

4. To No. 1 nitric acid may be added, and the ashes boiled in it till no more silver is extracted by it. The solution of silver nitrate thus produced is filtered off through white muslin, and put aside for further treatment.

5. The ashes may still contain silver chloride. This may be dissolved out by adding a solution of sodium hyposulphite, and adding the filtrate No. 3.

6. The solution from No. 4 may next be evaporated to dryness, and crystals of silver nitrate be produced, as given in page 174 ; or else common salt may be added, and the precipitate added to No. 2.

7. No. 2, after thoroughly drying, may be reduced to metallic silver in a reducing crucible* by addition of two parts of sodium carbonate and a little borax to one of the silver chloride. These should be well mixed together, and placed in the covered crucible in a coke fire, and gradually heated. (If the operator be in possession of one of Fletcher's gas furnaces, page 161, he can employ it economically, and with far less trouble than using the fire. It is supplied with an arrangement for holding crucibles, which is useful for the purpose.) After a time, on lifting off the cover, it will be found that the silver is reduced to a metallic state. After all conflagration has finished, the crucible should be heated to a white heat for a quarter of an hour. The molten silver should be turned out into an iron pan (previously rubbed over with plumbago to prevent the molten metal spirting), and immersed in a pail of water. The washing should be repeated till nothing but the pure silver remains.

8. Another method may be adopted, which is to place the chloride of silver in contact with sheet zinc or iron, covering it with water acidulated by oil of vitriol. The zinc or iron is converted into chloride, and the silver is deposited in a spongey mass.

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* The crucible should be of Stourbridge clay.

9. The chloride may also be dissolved in sodium hyposulphite, and added to 3.

The silver hyposulphite, having been reduced to the sulphide by the addition of the potassium sulphide, is placed in a crucible and subjected to a white heat; the sulphur is driven off, and the silver remains behind.

10. A last method is that of treating the whole of the residues as hyposulphite. A sheet of zinc is placed in the tub, and the silver is precipitated in a metallic state. The supernatant liquid is syphoned off, and replenished from the other waste solution. When the amount of silver deposited is sufficient, it is filtered out through fine calico and collected. After thorough washing it should be heated, to drive off the large amount of sulphur which is collected, and may be treated with nitric acid to form silver nitrate, or else be melted in a crucible with borax to form an ingot. If the plan be adopted of forming silver nitrate, the small amount of gold present will be left behind as a grey powder. This, after being well washed, may be treated with nitro-muriatic acid, as given below, and re-converted into tri-chloride. There will always be a certain amount of silver sulphate formed from the action of the nitric acid on the sulphur deposited with the silver.

TO MAKE GOLD TRI-CHLORIDE [AU CL_3].

Place a half-sovereign (which may contain silver as well as copper) in a convenient vessel; pour on it half a drachm of nitric acid, and mix with it two-and-a-half drachms of hydrochloric acid; digest at a gentle heat, but do not boil, or probably the chlorine will be driven off. At the expiration of a few hours add a similar quantity of the acids. Probably this will be sufficient to dissolve all the gold. If not, add acid the third time; all will have been dissolved by this addition, excepting, perhaps, a trace of silver, which will have been deposited by the excess of hydrochloric acid as silver chloride. If a precipitate should have been formed, filter it out, and wash the filter paper well with distilled water. Take a filtered solution of ferrous sulphate (eight parts water to one of iron) acidulated with a few drops of hydrochloric acid, and add the gold solution to it; the iron will cause the gold alone to deposit as metallic gold, leaving the copper in solution. By adding the gold solution to the iron the precipitate is not so fine as if added *vice versa*. Let the gold

settle, and pour off the liquid; add water, and drain again, and so on till no acid is left, testing the washings by litmus paper. Take the metallic gold which has been precipitated, re-dissolve in the acids as before, evaporate to dryness on a water bath that is at a heat not exceeding 212° F. The resulting substance is the gold tri-chloride. To be kept in crystals this should be placed in glass tubes hermetically sealed. For non-commercial purposes it is convenient to dissolve it in water (one drachm for a grain of gold). Ten grains of gold dissolved yield 15·4 grains of the salt. Hence if ten grains have been dissolved, 15·4 drachms of water must be added to give the above strength.

TO OBTAIN ALCOHOL FROM SPIRITS OF WINE.

Take pure carbonate of lime, and burn it thoroughly in a crucible, expelling all the carbonic acid. This product will be quicklime. Add this to the spirit of wine to be rectified, and leave it in a tightly-corked bottle for three or four days. The quicklime will absorb the water, leaving the alcohol nearly anhydrous; the alcohol, with the quicklime, may now be transferred to a glass flask and be distilled over. This gives absolute alcohol of 0·794.

If dry potassium carbonate be used instead of lime (see next article), and the distillization takes place, the resulting strength of alcohol is about ·814.

TESTING FOR THE AMOUNT OF WATER IN ALCOHOL.

Take a small quantity of chloroform and pour it into a graduated test tube. Add to it a given quantity of the alcohol to be tested. Shake up both well together. On settling, the water will have combined with the chloroform, and the difference in volume may be read off the test tube.

Another method is to add an *excess* of dry carbonate of potash to a given quantity, and then to read off the amount of fluid left, calculating it as of ·814 sp. gr. This obtains on account of the insolubility of the carbonate in alcohol and its affinity for water.

TESTING FOR METHYLATED ALCOHOL.

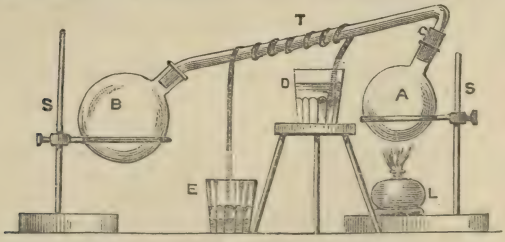
If a small quantity of caustic potash be added to alcohol suspected of being methylated, the presence of the impurity will be indicated by a brownish tint being given to the liquid.

REPARATION OF PLATINUM TETRA-CHLORIDE [Pt Cl_4].

Take any old scraps of platinum foil or wire, and having cleaned them with boiling nitric acid, place them in a porcelain dish containing aqua regia (four parts of hydrochloric to one of nitric acid). By the aid of heat this will cause a solution of platinum dichloride to be formed. The solution is evaporated nearly to dryness, or until it becomes viscous. It is then re-dissolved in water, and evaporated to the same state once more. For photographic purposes, this may be re-dissolved again in distilled water of the strength of one grain of the tetra-chloride to one drachm of water. It should be remembered that every ten grains of platinum yield 17·2 grains of the tetra-chloride; hence, with every ten grains of platinum dissolved, 17·2 drachms of water must be added to make it of the above strength.

TO MAKE A STILL FOR DISTILLING ALCOHOL.

The accompanying diagram shows the method for forming a



rough still, but one which is perfectly adapted for small distillation. A and B are two Florence flasks, supported, as shown, by two supports; S S earring rings. In the neck of A is fitted a perforated cork, C. A piece of quarter-inch soft glass tubing is bent in a common gas flame, and fitted into the cork, the long arm sloping slightly downwards. Two tumblers, D and E, are placed in position as shown. D is filled with water, and from it is carried a length of tow. This is wrapped round and round the tubing, and the other end is allowed to hang over E. Capillary attraction will cause the water to be carried round the tubing by the tow; this will ensure the latter always being cooled. Into the flask A is poured the liquid to be distilled,

and a spirit lamp, L, is placed below it. The vapour passes into the tube T, where it is condensed, and passes into B. To prevent the water running down T from the tow, a small india-rubber band should be made to fit tightly round the tube, a small pin inserted at the bottom to take off the drops. It is a more convenient arrangement to have a proper Liebig's condenser. This may be formed by encasing the glass tube in a water-tight tin tube having a small tube with a funnel attached to it at the bottom end, and an overflow tube at the top. Cold water is poured into the funnel, and forces out the warm water from the top. The tin tube may be fitted with corks at each end, through which holes may be cut to admit the glass tube T. This plan will be found of use for distilling alcohol or collecting the solvents from old collodion.

TO RECOVER ETHER AND ALCOHOL FROM OLD COLLODION.

Add to the collodion a little potash to neutralize all acidity, and also a small piece of metallic zinc. This will cause the iodine to form zinc iodide.

The solution may now be distilled over as given above, taking the precaution to fit a cork (through which a safety tube should pass to the bottom of the flask) into the bottle into which the condensed vapours pass.* The solvents may be used for fresh pyroxyline.

TO PREPARE ALBUMEN FOR SUBSTRATUM.

Place the albumen in a mortar with a little silica or fine *white* sand, and grind it till it is perfectly even. Next add the water required. This method may be substituted for that given previously.

TO DECOLOURIZE COLLODION.

Add to the collodion small strips of metallic cadmium, zinc, or silver, and shake well. With the first two metals the iodide formed will be dissolved by the collodion solvents. With the last the iodide will remain at the bottom of the bottle, except that part dissolved by the other soluble iodides.

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* The flask should be heated by hot water, till all the ether is distilled, if by the naked flame the ether vapour is given off too energetically.

TO CLEAN THE HANDS FROM SILVER AND IRON STAINS.

Take hydrochloric acid and dilute it to half its strength; or, better still, chloride of lime in strong solution. Pour a quarter of an ounce of this on the hands, and rub well in till the stains disappear. Iron stains may still remain of a greenish tint. *Rinse the hands*, and apply a little dilute solution of ammonia or potash. The hands will be found free from stains. This method avoids the use of potassium cyanide or sodium hyposulphite. Chlorides of the alkalies are sometimes recommended in lieu of the hydrochloric acid. They are not so effective. The hydrochloric acid does not discolour the hands permanently. The alkaline solution in any case restores the tissues to their proper colour. After alkaline development the stains may be got rid of by oxalic acid. In all cases potassium cyanide will be effective. This should only be used with excessive caution, on account of its poisonous character. Its free use is apt to cause paralysis.

TO TAKE SILVER AND IRON STAINS, ETC., OUT OF LINEN.

The same procedure as above is effective: iron and silver are converted into chloride, and pyrogallic acid is decomposed by the acid. The iron washes out, and the chloride of silver is afterwards dissolved by the ammonia.

To take stains out of cloth the same method may be tried, but it is rarely completely successful by any method, as the dye will be attacked by the acid. Potassium cyanide applied with soap may be tried, but it often leaves stains caused by the mordant of the dye.

GROUND GLASS.

When the ground glass of the camera has been broken, circumstances sometimes prevent it being replaced by a purchased article. The following method will give a substitute for it:—

Take a piece of glass of the size to be ground. Lay it flat on a board or table, sprinkle the finest emery over the surface, and moisten it. With another small piece of glass grind it smoothly and evenly till a uniform grain is apparent over the whole surface. The finer the emery the finer will be the resulting grain.

SUBSTITUTE FOR GROUND GLASS.

Sensitize a plate as usual, expose and develop till there is a fair deposit on the film (if the developer be acidified with nitric acid in lieu of acetic acid, the silver will be deposited in a white form); use the silver as the ground surface of the glass.

TO MIX SOLUTIONS CONTAINING GUM.

It is often necessary to mix solutions containing gum at a short notice. The gum should be pounded to powder in a mortar, and warm water added to it. It is easily filtered through "papier Joseph." On no account should a flask containing undissolved gum be placed over a naked flame, or the gum will then become decomposed. An enamelled glue pot is very useful for preparing gum solutions, the temperature of boiling water being thus never exceeded. Should gum be acid, it may be neutralized with lime-water. Lime-water is formed by placing a piece of burnt lime the size of a nut in a pint of water.

PURIFYING PRINTING BATHS.

The ordinary method of purifying a printing bath from the albuminate formed is to add a small quantity of pure kaolin, then to shake it up and filter. This method answers perfectly, but is rather wasteful.

If the bath be rendered quite neutral to litmus paper, and be placed in the sun, the organic matter is deposited together with the silver oxide, and the solution rendered pure.

If a small quantity of sodium chloride (common salt) be added, it will be found, on shaking up the silver chloride formed, that the organic matter is deposited with the chloride, and can be separated by filtration.

The addition of a sodium carbonate answers equally well, and may be used with advantage. It is generally advisable to have a small quantity of the carbonate of silver at the bottom of the bottle, as by so doing, the neutral condition of the bath is ensured, and the organic matter is continually being deposited.

TO INTENSIFY A NEGATIVE AFTER VARNISHING.

A negative may be rendered more intense after varnishing by adding iodine to the varnish till it assumes a light port wine colour, and re-varnishing with this solution in the ordinary manner.

A SIMPLE METHOD OF ADDING EXTRA BROMIDE TO A COLLODION.

Dissolve eighteen grains of bromide in an ounce of collodion. The addition of a drachm of this to each ounce of the collodion will give (very nearly) an extra two grains of bromide.

TO INTENSIFY A NEGATIVE BY THE ACTION OF LIGHT.

If, after developing, the negative be well washed, and exposed to sunlight till the unaltered silver salts assume a brownish colour, the intensity of the negative will be found to be materially increased.

TO RETOUCH VARNISHED NEGATIVES.

To retouch negatives a blacklead pencil is found to give the best results (B answers well). When varnished the negative requires a "tooth" given it to take the pencil. This is best obtained by taking *very finely powdered* resin, and rubbing it gently over the part required to be retouched. Finely-powdered pumice may be substituted for the resin.

If a negative be varnished without heat, a sufficient tooth will also be given; but great care is required, in re-varnishing it, to preserve the blacklead from running. In this case the second coating of varnish should be applied cold, and the plate be afterwards well heated.

TO BEND GLASS TUBING.

Ordinary glass tubing can be bent by simply placing the part where the curve is required in the flame of a spirit lamp, or in an ordinary gas flame. The tube should be held by the two hands, and turned round between the fingers, so that the whole of the surface to be acted upon gets equally heated.

When the glass feels softened, a gentle pressure by the hands will give the necessary bend. If the heating be too great, the tubing will not remain circular in section at the head, but will be flattened.

TO MAKE A SYPHON.

Bend a piece of tubing, pierce a cork with two holes, and in one fit tightly one leg of the bent tubing, and in the other fit in a piece of straight tubing. To use the syphon, if the cork fit the bottle, press it tightly into the neck, or if it be larger, press it firmly on to its lip. See that the straight tube is above the level of the liquid, whilst the leg is well in it. Blow down the former till the liquid rise past the bend of the latter, when a constant flow will result, till the level of the inner or outer leg is reached.

TO REMOVE THE VARNISH FROM A NEGATIVE.

Varnish may be removed from a negative by warming it gently, and applying spirits of wine to its surface *gently*. The spirit must be poured off, the plate re-heated, and a fresh quantity applied as before. This operation must be continued till the varnish appears to be totally dissolved from the surface of the negative. Alcohol vapour made by heating spirits of wine over a spirit lamp in a test tube is very rapid in its solvent action. A final rinse of spirits should, however, always be given. Caustic potash will also remove most varnishes.

CONVENIENT DROPPING BOTTLES.

A convenient dropping-bottle may be formed with any ordinary four or six-ounce bottle by cutting a slot in the cork from end to end, and fixing it in the bottle in the ordinary manner. If this and an ordinary cork be attached to the neck of the bottle by twine, the two may be interchanged as required.

TO TEST FOR IRON IN A FILTER PAPER.

Moisten the filter paper with a drop or two of hydrochloric acid. Then add a drop of ferricyanide of potassium to the moistened part. A blue stain will show the presence of sufficient iron to be injurious to a bath solution.

TO SILVER GLASS FOR MIRRORS.*

Prepare three standard solutions :—

No. 1.—Silver nitrate ...	...	... 90 grains
Distilled water	...	... 4 ounces
No. 2.—Potash (*pure*)	...	... 1 ounce
Distilled water	...	... 25 ounces
No. 3.—Milk sugar ...	...	... $\frac{1}{2}$ ounce
Distilled water	...	... 5 ounces

Nos. 1 and 2 will keep indefinitely ; No. 3 should be prepared immediately before use.

Pour two ounces of No. 1 into a glass vessel capable of holding 35 fluid ounces ; add drop by drop (stirring all the time) as much liquor ammonia as will just dissolve up the first precipitate caused by it ; add four ounces of No. 2. The new precipitate must be dissolved up once more by ammonia. Add distilled water till the bulk reaches 15 ounces, and add drop by drop some of No. 1, until a grey precipitate is just formed which does not dissolve after stirring for three minutes. Add 15 ounces more of distilled water. Set this solution aside to settle, but it must not be filtered.

When all is ready for immersing the mirror, add to the silvering solution two† ounces of No. 3. No. 3 may be filtered.

Melt some soft pitch and run it into water to partially cool it, and take a common pencil and cause sufficient of the pitch to adhere to it to form a good large seal when pressed on to the back of the plate, adhesion to which is caused by a little turpentine (gutta-percha may be melted in hot water, and employed similarly, omitting the turpentine). The pencil fixed vertically to and in the centre of the plate by means of the pitch, no further step must be taken till the latter is quite cool and hard. The glass plate should be worked, or at the least a good specimen of patent plate. The surface which is to be silvered is next to be cleaned by nitric acid, rubbing it gently with a brush of cotton wool or the "Blanchard brush." It is then washed well with common water, and finally rinsed with distilled

* The substance of the article is taken from Browning's "Plea of Reflectors."

† The writer has found that 3 ounces sometimes aids the complete deposition of the silver."

water. The glass is placed in distilled water till the silvering fluid is ready.

In a dish about three inches deep, and slightly larger than the glass, the solution No. 3, and the silvering solutions made of Nos. 1 and 2 and ammonia, should be mixed, and the plate be suspended by a clamp or from a loop tied into the pencil in the fluid just so far that the back is not covered. After sixty to ninety minutes the silvering will be complete, and the glass must be removed and immediately washed thoroughly, and finally rinsed with distilled water. It should then be placed on end, on blotting-paper, and be allowed to dry *perfectly*. When dry the surface is polished by rubbing circularly with a piece of the softest wash-leather, and finally by the addition of the finest jeweller's rouge.

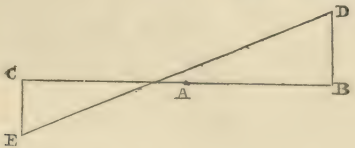
The pitch is then separated from the glass by a chisel, and any small particles remaining are removed by scraping and by a little turpentine.

Success in the operation is greatly dependent on not using an excess of ammonia, and on the purity of the distilled water.

TO FIND THE EQUIVALENT FOCUS OF A LENS, AND ITS DISTANCE FROM AN OBJECT FOR ENLARGING, ETC.

The equivalent focus of a lens is a term applied to a compound lens. It is the focus of parallel rays entering the lens. It is termed "equivalent" from being compared with a single lens that would produce the same sized image at the same distance from the object.

Measure a distance of (say) one hundred and fifty feet away from some fixed point, and place a rod at one extremity. From this point measure a line exactly at right-angles to the first of



some forty feet in length, and place another rod at its other end. Now place the front of the camera exactly over the starting point of the first line and level it, the lens being in the direction of the first line. Having marked a central vertical line on

the ground glass with a pencil, focus the first rod accurately, so as to fall on the pencil line on the ground glass. Take a picture of the two rods in the ordinary way, and measure back as accurately as practicable the distance of the centre of the ground glass from the starting point, and also the distance apart of the two images of the rods (at their base) upon the negative.

Suppose the first measured line, AB, to be 149′; BD, the second line, to be 35′; AC to be 1′; and EC, the distance apart of the two images, to be 3″, F being the point where DE cuts CB.

Then BD+CE : CB :: CE : CF, which is the equivalent focal distance.

Here, CB=150 ft. BD+CE=35·25′ ft. CE=·25 ft.

$$\therefore CF=\frac{150+\cdot 25}{35\cdot 25}=1\cdot 063 \text{ ft.}$$

This gives the equivalent focal distance, which is the distance of the ground glass from the optical centre. Having taken the thickness of the ground glass previously, the distance may be set off from its smooth side on to the brass work of the lens by a pair of callipers. This point (the optical centre) having once been obtained, its position should be marked on the brass work, and from it all measurements should be calculated. This method is *very nearly* mathematically accurate. Were the distance taken of shorter length than those given, an appreciable error might be found. At the distance given the rays of light entering the lens from the rod are virtually parallel, and thus fulfil the necessary conditions. It must also be remarked that the distance AB being so great in comparison with AC as that any slight error in the back measurement will affect the result by an inappreciable quantity, CE should be measured most accurately from the negative. The mean of a series of trials should be taken.

Having obtained the equivalent focal distance of the lens, the respective distance of the object and ground glass from the optical centre can be obtained by the following formula:—

$$v=\frac{f(n+1)}{n} \text{ and } u=nv$$

where v is the distance of the focussing screen, u that of object from the optical centre, n being the linear reduction, or enlargement.

On the following page is a table of enlargement or reduction for lenses with certain equivalent focal distances.

TABLE OF ENLARGEMENT OR REDUCTION.

Equivalent Focus of Lens.	Reduction.	Enlargement or Reduction. 1	2	3	4	5	6	Enlargement.	Remarks.
6″	*u*	12	18	24	30	36	42	*v*	*v* = distance of image on ground glass, and *u* = distance of the object from the centre.
	v	12	9	8	$7\frac{1}{2}$	$7\frac{1}{5}$	7	*u*	
$6\frac{1}{2}$	*u*	13	$19\frac{1}{2}$	26	$32\frac{1}{2}$	39	$45\frac{1}{2}$	*v*	
	v	13	$9\frac{3}{4}$	$8\frac{2}{3}$	$8\frac{1}{8}$	$7\frac{4}{5}$	$7\frac{7}{12}$	*u*	
7	*u*	14	21	28	35	42	49	*v*	
	v	14	$10\frac{1}{2}$	$9\frac{1}{3}$	$8\frac{3}{4}$	$8\frac{2}{5}$	$8\frac{1}{6}$	*u*	
$7\frac{1}{2}$	*u*	15	$22\frac{1}{2}$	30	$37\frac{1}{2}$	45	$52\frac{1}{2}$	*v*	
	v	15	$11\frac{1}{4}$	10	$9\frac{3}{8}$	9	$8\frac{3}{4}$	*u*	
8	*u*	16	24	32	40	48	56	*v*	
	v	16	12	$10\frac{2}{3}$	10	$9\frac{3}{5}$	$9\frac{1}{6}$	*u*	
$8\frac{1}{2}$	*u*	17	$25\frac{1}{2}$	34	$42\frac{1}{2}$	51	$59\frac{1}{2}$	*v*	
	v	17	$12\frac{3}{4}$	$11\frac{1}{3}$	$10\frac{5}{8}$	$10\frac{1}{5}$	$9\frac{7}{12}$	*u*	
9	*u*	18	27	36	45	54	63	*v*	
	v	18	$13\frac{1}{2}$	12	$11\frac{1}{4}$	$10\frac{7}{8}$	$10\frac{1}{2}$	*u*	
$9\frac{1}{2}$	*u*	19	$28\frac{1}{2}$	38	$47\frac{1}{2}$	57	$66\frac{1}{2}$	*v*	
	v	19	$14\frac{1}{4}$	$12\frac{2}{3}$	$11\frac{7}{8}$	$11\frac{2}{5}$	$11\frac{1}{12}$	*u*	
10	*u*	20	30	40	50	60	70	*v*	
	v	20	15	$13\frac{1}{3}$	$12\frac{1}{2}$	12	$11\frac{2}{3}$	*u*	
$10\frac{1}{2}$	*u*	21	$31\frac{1}{2}$	42	$52\frac{1}{2}$	63	$73\frac{1}{2}$		
	v	21	$15\frac{2}{3}$	14	$13\frac{1}{8}$	$12\frac{3}{5}$	$12\frac{3}{4}$	*u*	
11	*u*	22	33	44	55	66	77	*v*	
	v	22	$16\frac{1}{2}$	$14\frac{2}{3}$	$13\frac{3}{4}$	$13\frac{1}{3}$	$12\frac{5}{6}$	*u*	
$11\frac{1}{2}$	*u*	23	$34\frac{1}{2}$	46	$57\frac{1}{2}$	69	$80\frac{1}{2}$	*v*	
	v	23	$17\frac{1}{4}$	$15\frac{1}{3}$	$14\frac{3}{8}$	$13\frac{4}{5}$	$13\frac{5}{12}$	*u*	
12	*u*	24	36	48	60	72	84	*v*	
	v	24	18	16	15	$14\frac{2}{5}$	14	*u*	

Applying this table to an example :—Suppose the equivalent focal distance of the lens to be $9\frac{1}{2}''$, and that it is desired to find the distance at which the ground glass and the object are to be placed, to give an enlargement of four times linear (*i.e.*, sixteen times in area). In the first column find $9\frac{1}{2}$, and trace it horizontally till it reaches the column headed 4. Then $47\frac{1}{2}''$ will be the distance of the screen from the optical centre of the lens; and $11\frac{7}{8}$ the distance of the object from the same point.

Where any lens is used for copying, it is useful to find out the *exact* equivalent focus, and to make a table similar to this for it. By so doing, if a scale be marked on the base-board of the camera, the plan or object to be enlarged or reduced may be placed in proper position at once, as may also the ground glass.

DETERMINATION OF THE STRENGTH OF ACETIC ACID.

To determine the strength of this acid volumetrically is somewhat difficult, owing to the fact that sodium acetate possesses a feeble alkaline re-action. The most direct method is to take a known quantity of finely powdered marble or precipitated chalk (calcium carbonate), and add it to a certain quantity of the acid. After boiling, the calcium carbonate which is undissolved should be dried and weighed after washing in *hot* water.

As an example, one fluid drachm of acetic acid was taken, and to it was added 100 grains of finely powdered marble, after filtering, washing, and drying, the residual marble was detached from the filter paper, and found to weigh 52·2 grains; therefore the amount of calcium carbonate converted into calcium acetate was 47·8 grains.

The atomic weight of calcium carbonate $CaCO_3$ = 100
" " acetic acid $C_2H_4O_2$ ... = 60

100 : 60 : : 47·8 grains : x

$\therefore x = 21{\cdot}68$ grains

The same quantity of glacial acetic acid at 60 weighs 57·8 grains.

The solution under consideration contains 49·5 per cent. acid.

DETERMINATION OF THE STRENGTH OF NITRIC ACID.

Procure some finely dried powdered chalk or marble, and place in a beaker in which has previously been placed 1 drachm of nitric acid diluted with another drachm of water. When all effervescence has ceased, filter off the residue, wash well in hot water, and deduct the weight formed from the original quantity. This gives the amount of calcium carbonate converted into calcium nitrate.

The atonic weight of calcium carbonate $CaCO_3$ = 100
" " " nitric acid HNO = 63
Then 100 : 63 :: weight of lime dissolved : nitric acid.

Note.—At 60° F. nitric acid of 1·457° specific gravity contains 79 per cent. of nitric acid, and at 1·420, 69·20 per cent.

These specific gravities are those mentioned in the work.

DETERMINATION OF THE STRENGTH OF SULPHURIC ACID.

This cannot be determined by calcium carbonate, as the calcium sulphate is sparingly soluble in water; in this case, recourse may be had to taking a fixed quantity of the acid as before, and precipitating it with barium chloride, forming insoluble barium sulphate, which, after washing, is weighed. Taking the atomic weight as before—

230 : 98 :: weight of precipitate : sulphuric acid (HSO_4)

Note.—At 60° Fah. sulphuric acid of 1·840 contains 97 per cent. of H_2SO_4.

WEIGHTS AND MEASURES.

1 Sovereign weighs	...	...	123·274 grains
1 Shilling "	...	...	87·273 "
48 Pence "	...	...	1 lb. avoirdupois
1 Half-penny = 1 inch in diameter			

Avoirdupois Weight.

16 Drachms ...	...	1 ounce (=437·5 grains)
16 Ounces ...	...	1 lb. (=7,000 grains)

Troy Weight.

24 Grains	...	...	1 pennyweight
20 Pennyweights	...	...	1 ounce
12 Ounces	...	...	1 pound

Apothecaries' Weight, Solid Measure.

20 Grains	...	...	1 scruple
3 Scruples	...	...	1 drachm
8 Drachms	...	...	1 ounce
12 Ounces	...	...	1 pound

Apothecaries' Fluid Measure.

60 Minims	...	...	1 drachm
8 Drachms	...	...	1 ounce
16 Ounces	...	...	1 pound
20 Ounces	...	...	1 pint
8 Pints	...	...	1 gallon

French Weights.

1 Gramme	... 15·432 grains
Kilogramme	... 1000 grammes (=2·2 lbs. Avoir. nearly)

French Fluid Measure.

1 Litre ...	...	35·216 ounces (fluid)
1 Centimetre	...	17 minims nearly
50 Centimetres	1 ounce	6 drachms 5 minims

French Linear Measure.

1 Metre	...	...	...	39·37 inches

Silver nitrate is sold by avoirdupois weight. All formulæ in the book are to be made up by apothecaries' weight.

TABLE SHOWING THE SPECIFIC GRAVITY OF ABSOLUTE ALCOHOL WHEN COMBINED WITH VARYING QUANTITIES OF WATER AT 60° FAH.

Alcohol per cent.	Specific Gravity	Alcohol per cent.	Specific Gravity.
50	·9228	85	·8357
55	·9068	86	·8331
60	·8956	87	·8305
65	·8840	88	·8279
68	·8769	89	·3254
70	·8721	90	·8228
72	·8672	91	·8199
74	·8625	92	·8172
76	·8581	93	·8145
78	·8533	94	·8118
79	·8508	95	·8089
80	·8483	96	·8061
81	·8459	97	·8031
82	·8434	98	·8001
83	·8408	99	·7969
84	·8382	100	·7938

TABLE OF THE SYMBOLS AND ATOMIC WEIGHTS OF THE MOST COMMON ELEMENTS.

Name.		New Notation.	Old Notation.	Name.		New Notation.	Old Notation.
Aluminium	Al	27·4	13·7	Lead	Pb	207	103·5
Antimony	Sb	122·0	122	Lithium	Li	7	7
Arsenic	As	75	75	Magnesium	Mg	24	12
Barium	Ba	137	68·5	Manganese	Mn	55	27·5
Bismuth	Bi	210	210	Mercury	Hg	200	100
Boron	B	11	11	Nickel	Ni	58·7	29·35
Bromine	Br	80	80	Nitrogen	N	14	14
Cadmium	Cd	112	56	Oxygen	O	16	8
Calcium	Ca	40	20	Palladium	Pa	106·6	53·3
Carbon	C	12	6	Phosphorus	P	31	31
Chlorine	Cl	35·5	35·5	Platinum	Pt	98·7	98·4
Chromium	Cr	52·2	26·3	Potassium	K	39·1	39·0
Cobalt	Co	59	29·5	Silicon	Si	28	14·0
Copper	Cu	63·5	31·75	Silver	Ag	108	108·0
Fluorine	F	19	19	Sodium	Na	23	23·0
Gold	Au	197	197	Strontium	Sr	87·5	43·8
Hydrogen	H	1	1	Sulphur	S	32	16·0
Iodine	I	127	127	Tin	Sn	118	59·0
Iridium	Ir	198	99	Uranium	U	120	60·0
Iron	Fe	56	28	Zinc	Zn	65·2	32·6

CHEMICAL COMPOUNDS TO WHICH REFERENCE IS MADE IN THE BOOK.

New Nomenclature.	New Notation.	Old Nomenclature.	Old Notation.
Ammonium bromide	$NH_4 Br$	... Bromide of ammonium	$NH_4 Br$
,, chloride	$NH_4 Cl$	... Chloride of ammonium	$NH_4 Cl$
,, iodide	$NH_4 I$	... Iodide of ammonium	$NH_4 I$
Barium nitrate	$Ba(NO_3)_2$	... Nitrate of baryta	$BaO\ NO_5$
,, sulphate	$Ba SO_4$	... Sulphate of baryta	$BaO\ SO_3$
Cadmium bromide	$Cd Br_2$	... Bromide of cadmium	$Cd Br$
,, chloride	$Cd Cl_2$	... Chloride of cadmium	$Cd Cl$
,, iodide	$Cd I_2$	... Iodide of cadmium	$Cd\ 1$
Calcium chloride	$Ca Cl_2$	... Chloride of calcium	$Ca Cl$
Copper chloride	$Ca Cl_2$	... Chloride of copper	$Cu Cl$
Ferric nitrate	$Fe(NO_3)_3$	... Pernitrate of iron	$Fe_2O_3 3NO_5$
,, sulphate	$Fe_2(SO_4)_3$	... Persulphate of iron	$Fe_2O_3 3SO_3$
Ferrous nitrate	$Fe(NO_3)_2$	... Proto-nitrate of iron	$FeO\ NO_5$
,, sulphate	$Fe SO_4$	... Protosulphate of iron	$FeO\ SO_3$
Gold trichloride	$Au Cl_3$	... Terchloride of gold	$Au Cl_3$
Hydrogen sulphide	$H_2 S$	... Sulphuretted hydrogen	$H S$
Iridium chloride	$Ir Cl_3$	... Chloride of iridium	$Ir_2 Cl_3$
Mercuric dichloride	$Hg Cl_2$	... Bichloride of mercury	$Hg Cl_2$
Platinum tetrachloride	$Pt Cl_4$	... Bichloride of platinum	$Pt Cl_2$
Potassium bromide	$K Br$	... Bromide of potassium	$K Br$
,, chloride	$K Cl$	... Chloride of potassium	$K Cl$
,, iodide	$K I$	... Iodide of potassium	$K I$
,, dichromate	$K_2 Cr_2 O_7$	... Bichromate of potash	$KO\ 2CrO_3$
,, permanganate	$KMn O_4$	... Permanganate of potash	$KO, Mn_2 O_7$
Silver bromide	$Ag Br$	... Bromide of silver	$Ag Br$
,, chloride	$Ag Cl$	... Chloride of silver	$Ag Cl$
,, iodide	$Ag I$	... Iodide of silver	$Ag I$
,, oxide	$Ag_2 O$	... Oxide of silver	$Ag O$
,, nitrate	$Ag NO_3$	... Nitrate of silver	$Ag O\ NO_5$
,, sulphate	$Ag_2 SO_4$	... Nitrate of uranium	$Ur_2 O\ SO_4$
Sulphuric acid	$H_2 SO_4$	... Sulphate of silver	$Ag O\ SO_2$
Uranium nitrate	$U SO_4$	... Sulphuric acid	$HO\ SO_3$
Zinc iodide	$Zn I_2$	... Iodide of zinc	$Zn I$
,, bromide	$Zn Br_2$	... Bromide of zinc	$Zn Br$
,, chloride	$Zn Cl_2$	... Chloride of zinc	$Zn Cl$

ABSTRACT OF STORES REQUIRED FOR PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

Acid, hydrochloric (in stoppered bottles.)	...	1 lb.
,, nitric (in stoppered bottles.)	...	1 ,,
,, sulph. (in stoppered bottles.)	...	1 ,,
Cloths, cheese	...	2
Cotton waste	...	
Eraser, metal, with box-wood handle	...	1
,, with sheath	...	1
Galls, bruised	...	1 ,,
Gum-arabic	...	½ ,,
Handles, leather, for rollers	...	1 pair
Ink, black, in tin	...	1 lb.
Knives, palette	...	2
Millboards (thickest)	...	10 lbs.
Mullers, zinc	...	2
Oil, olive	...	½ pint
,, green	...	1 ,,
Plates, zinc (according to size of press), No. 10 guage.		
Press, lithographic	...	
Roller, ordinary	...	1
,, smooth	...	1
Sand moulders	...	¼ bsh.
Scrapers, box-wood, for press	...	2
Sieve, 120 hole	...	1
Sponges	...	2
Stone, pumice	...	4 lbs.
,, snake	...	2 ,,
Stone, litho., fine and free from chalk	...	
Glaze boards	...	2
Paper, glass	...	6 shts.
Phosphorus	...	1 oz.

KIT THAT MAY BE NECESSARY FOR ONE DAY'S WORK IN THE FIELD.

Camera.
Dark Slides.
Camera Legs.
Lenses.
Focussing Cloth.
Do. Glass.
Glazier's Diamond.
Circular Spirit Level.
Tent.
Water Bag and Clip.
Tent Legs.
Yellow Silk Handkerchief.
Bath.
Dipper.
Glass Plates.
Plate Boxes.
Funnel.
Filter Paper.
4-oz. Measure.
Cotton Wool.
Chamois Leather.
Diaper Dusters.
Dusting Brush.
Developing Cups.
Plate Holder.
Emery Powder.
Tripoli Powder.
Spirits of Wine.
Bath Solution.
Collodion.
Developer, 10 grs.
Do., 50 ,,
Intensifier, Iron
Do., Pyrogallic
Silver Nitrate Solution, 20 grains.
Potassium Cyanide.
Iodine Solution.
Tannin and Glycerine Solution.
Glacial Acetic Acid.
Golden Syrup Solution.
Spirit Lamp.
Bottle of Spirit.
Varnish.

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P. MEAGHER,

PHOTOGRAPHIC APPARATUS MANUFACTURER.

AWARDS.
- *International Exhibition*, 1862.—HIGHEST AWARD.
- *Photographic Society of Scotland*, 1863.—ONLY MEDAL.
- *Berlin International Exhibition*, 1865.—MEDAL.
- *North London Exhibition*, 1865.—ONLY PRIZE MEDAL.
- *Dublin International Exhibition*, 1865.—HIGHEST AWARD.
- *Paris Universal Exhibition*, 1867.—ONLY MEDAL FOR CAMERAS.

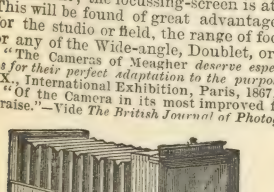
The above are the only Exhibitions where I have been an Exhibitor; and the award of each Jury was for great excellence in design and manufacture of Cameras.

MEAGHER'S NEW FOLDING CAMERA.

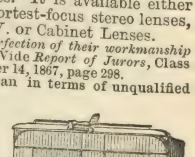
This CAMERA is similar in construction to the already well-known Binocular Camera, and possesses the following advantages over the existing Landscape or Kinnear form of Camera:—No screws are required for fixing; the focussing is effected from the back by the screw adjustment; the focussing-screen is attached to the camera, and the bellows body is PARALLEL. This will be found of great advantage when using wide-angle lenses. It is available either for the studio or field, the range of focus permitting the use of the shortest-focus stereo lenses, or any of the Wide-angle, Doublet, or View Lenses, also for the C.D.V. or Cabinet Lenses.

"The Cameras of Meagher *deserve especial examination, as well for the perfection of their workmanship as for their perfect adaptation to the purposes for which they are designed.*"—Vide *Report of Jurors*, Class IX., International Exhibition, Paris, 1867. *Illustrated London News*, September 14, 1867, page 298.

"Of the Camera in its most improved form we cannot speak otherwise than in terms of unqualified praise."—Vide *The British Journal of Photography*, March 8, 1867.



This Camera is used in the Government Photographic Departments, and by nearly all the best Amateur and Professional Photographers; and has been adopted by nearly every Maker of, and Dealer in, Cameras, both at home and abroad. See the various Illustrated Catalogues.



These Cameras were selected by Captain Abney, R.E., for the Photographic Equipment of H.M.S. "Challenger," the American Boundary Commission, and the Arctic Expedition.

Prices for Pictures.		Swing-back extra.		Brass Binding.		Russia-leather Bellows.	
8½ by 6½	£5 16 0	£0 15 0		£1 0 0		£0 18 0	
8½ by 8½	6 10 0	0 15 0		1 0 0		0 18 0	
10 by 8	6 16 0	1 0 0		1 5 0		1 1 0	
10 by 10	7 10 0	1 0 0		1 5 0		1 1 0	
12 by 10	8 0 0	1 5 0		1 10 0		1 7 0	
12 by 12	8 15 0	1 5 0		1 10 0		1 7 0	
15 by 12	10 0 0	1 10 0		2 0 0		1 17 6	
15 by 15	11 10 0	1 10 0		2 0 0		1 17 6	

The above prices include one Single Back and two Inner Frames.

If required for copying purposes, these Cameras are made with extending fronts, and can also be fitted with Repeating Back for two Cabinets and two C.D.V. pictures on one plate, thus meeting all the requirements of the practical photographer. For the larger sizes, above 8½×6½, I recommend the square form and swing back.

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To THE SECRETARY OF STATE FOR INDIA, IN COUNCIL,

To THE CROWN AGENTS FOR THE COLONIES,

To THE SURVEY COMMISSIONER FOR INDIA,

To THE SURVEY COMMISSIONER FOR NEW ZEALAND,

To THE ORDNANCE SURVEY OFFICE,

To THE ASTRONOMER ROYAL,

To THE ROYAL SOCIETY,

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AT SOUTHAMPTON,
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No. 1B, for Cards, distance 12 ft. ...	6	5 0
No. 1B (long) ditto „ 14 ft. ...	6	15 0
No. 2B ordinary ditto „ 18 ft. ...	12	16 0
No. 2B Patent ditto „ 18 ft. ...	13	5 0
No. 3B ditto for Cabts.„ 18 ft. ...	20	0 0
No. 4B ditto ditto „ 24 ft. ...	40	0 0

ORDINARY INTENSITY (A.)

No. 1A, Patent, for Cabinets, in short rooms (distance 14 feet) ...	13	0 0
No. 2A, Patent, for Cabinets (distance 20 feet) and up to 8½×6½ ...	18	0 0
No. 3A, Patent, for Cabinets (distance 24 feet) and up to 9×7 ...	27	5 0
No. 4A, Patent, for Imperial Portraits and 10×8 plates	38	10 0
No. 5A, Patent, for plates 16×13 and under	50	0 0
No. 6A, Patent, for plates 20×16 and under	60	0 0

PORTRAIT AND GROUP (D).

No. 3D, Patent, for 8½ × 6½ and Views 10×8	9	10 0
No. 4D, Patent, for 10×8 ditto, 12×10	13	10 0
No. 5D, ditto, for 12×10 ditto, 15×12	17	10 0
No. 6D, ditto, for 15×12 ditto, 18×16	26	10 0
No. 7D, ditto, for 18×16 ditto, 22×20	48	0 0
No. 8D, ditto, for 22×20 ditto, 25×21	58	0 0

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New Stereoscopic Lens, 3½in. focus, ea.	3	10 0
Ditto, with rack-and-pinion „	4	0 0
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3	10 × 8	10	5 10 0
4	12 ×10	12	7 0 0
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6	18 ×16	18	10 10 0
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